place a 1-cent stamp on this letter, mail it to any soldier or sailor employee, and it will be placed in the hands of our soldiers or sailors at the front. No wrapping; no address.

A. S. Burleson, Postmaster General.

The Welding Engineer

Vol. III. Chicago 608 S. Dearborn St. FEBRUARY, 1918 $2.00 per year in U. S. $2.50 per year abroad No. 2

Speeding Up for Liberty

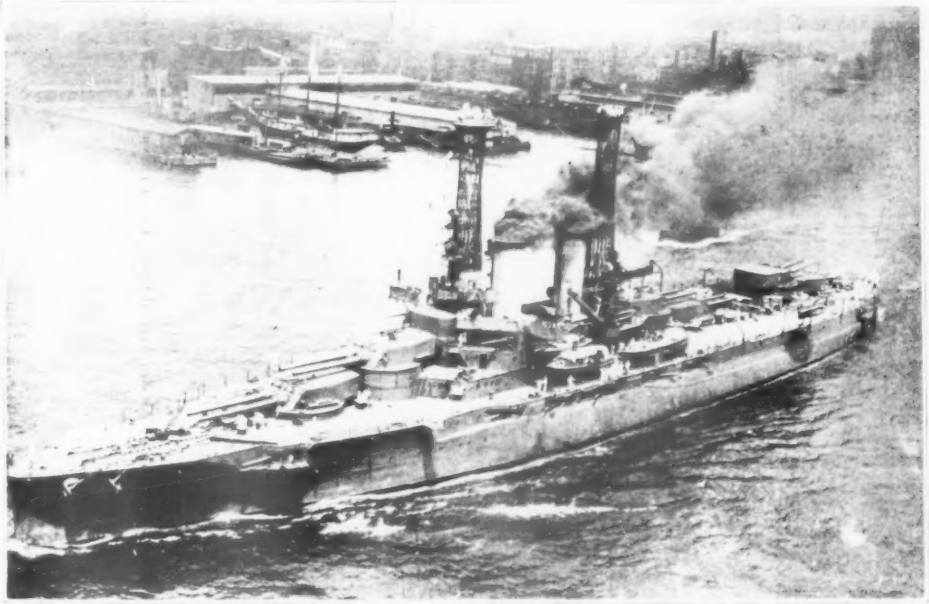
The development of oxy-acetylene welding has enabled Uncle Sam's ship builders materially to cut their former time schedules for the construction of boats of all types and tonnage.

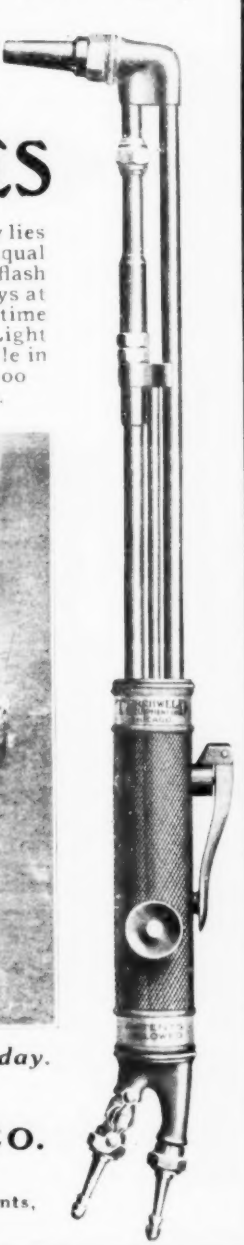
"TORCHWELD" TORCHES

are playing a conspicuous part in this vitally important work.

"Torchweld" Welding Torch and "Torchweld" Cutting Torch speed up by functioning efficiently and steadily, with none of the difficulties incident to the use of the ordinary torch.

The secret of their higher efficiency lies in the perfect gas mixture and equal pressure on both gases. They don't flash don't go out. They cause no delays at any stage of the work. They save time that other torches would "kill." Light in weight therefore easier to handle in all positions. More economical too they use less fuel gas and oxygen.





Get Posted on "Torchweld" Torches. Send us your inquiry today. Ask Our Advice on Welding Problems.

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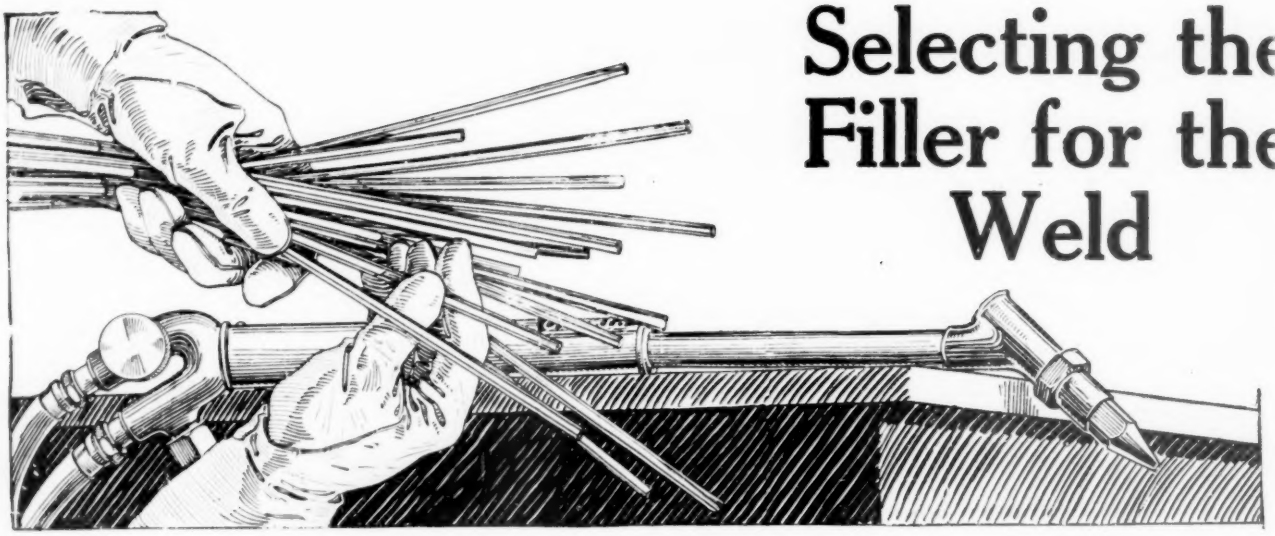
230 North Carpenter Street, Chicago

Manufacturers of High Grade Welding and Cutting Equipments, Welding Materials, Fluxes, Supplies and Accessories



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OUR intensely interesting supply catalogue and text book describes fifteen different sorts of FILLER RODS—all made to meet our own laboratory specifications and tests covering every quality and factor of chemical composition. The same booklet describes six different fluxes—as scientifically made as the rods.

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We guarantee Oxweld supplies, when used by competent welders, to give better results than any others known to the art.

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World's Largest Makers of Oxy-Acetylene Apparatus and Supplies

P-4

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Exceptionally durable construction of torches insures long, satisfactory service. Regulators dependable and free from valve, diaphragm and gauge troubles.

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CHICAGO NEW YORK

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October 4, 1917
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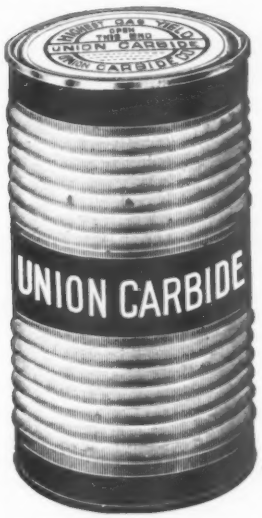

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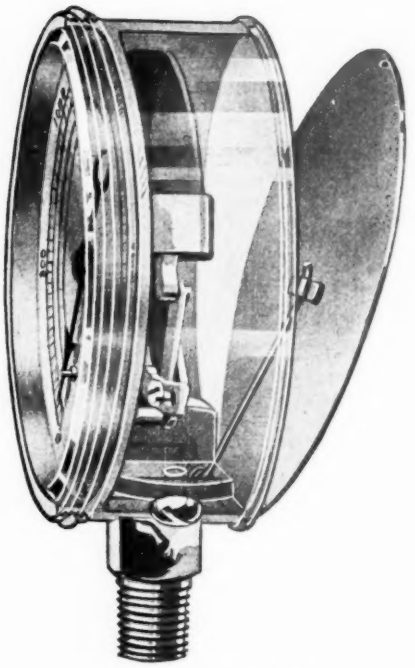

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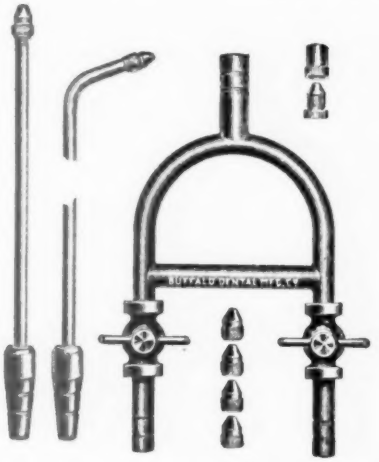

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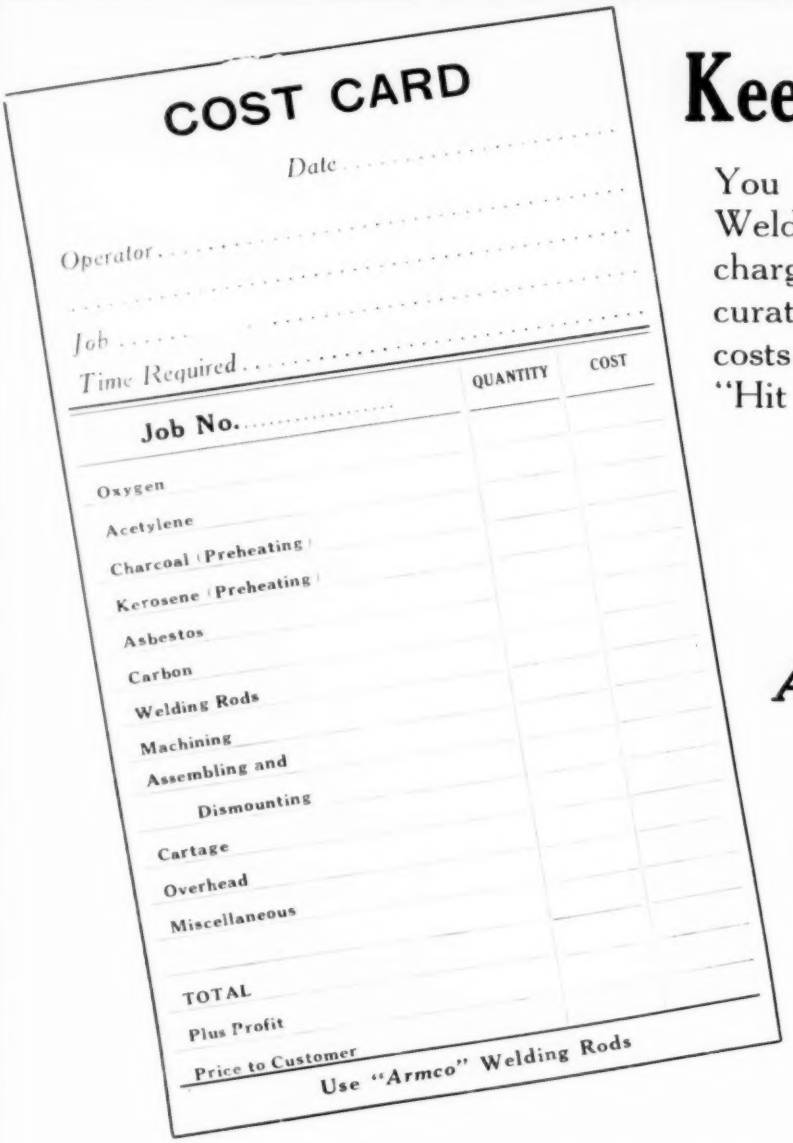

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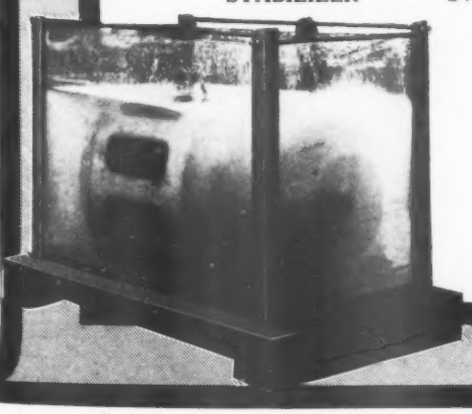

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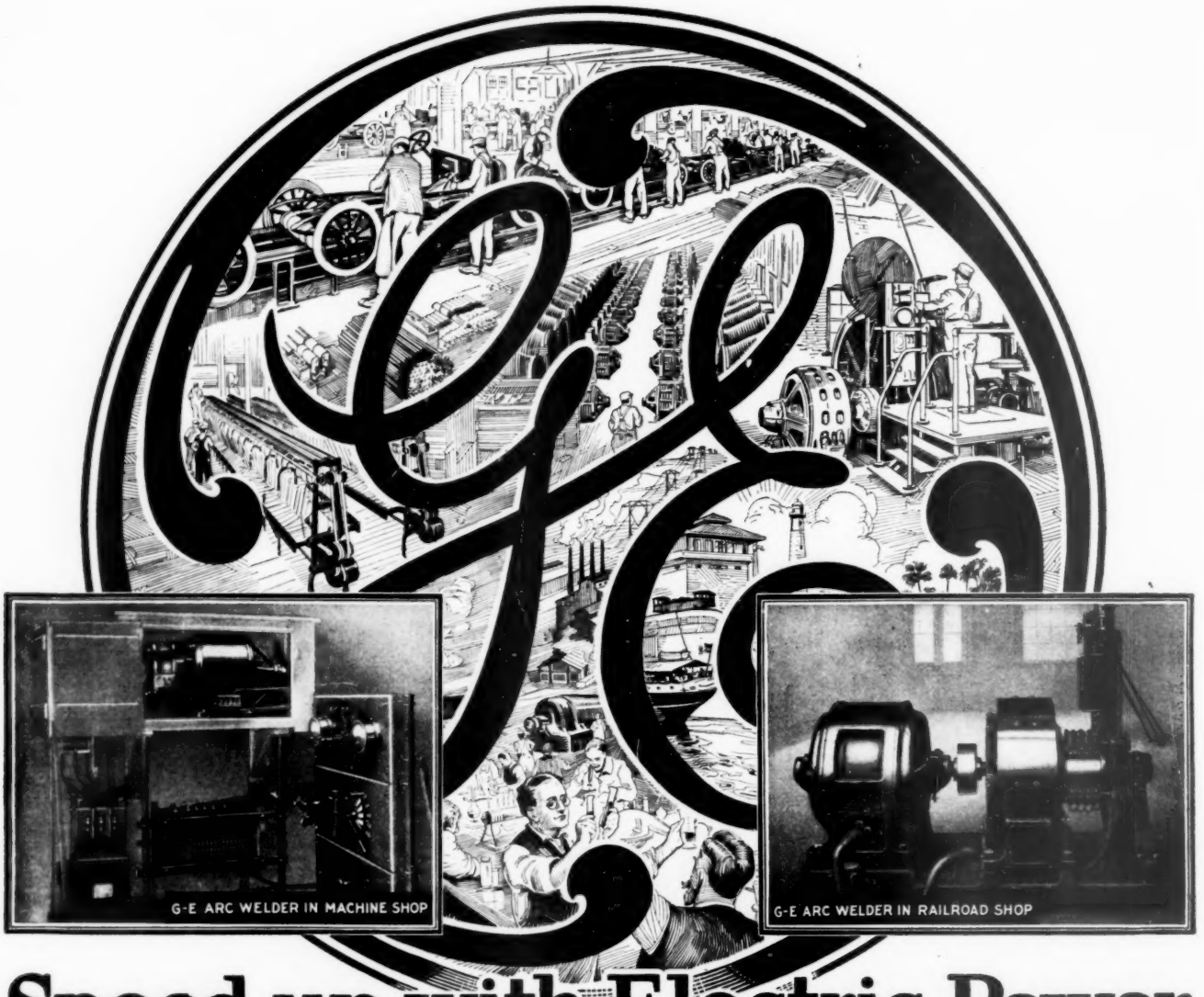

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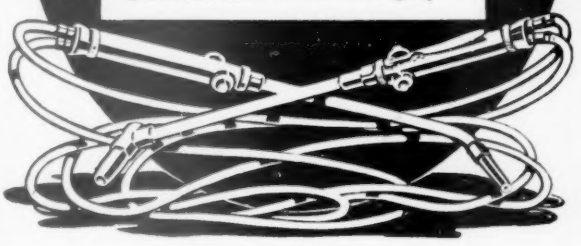

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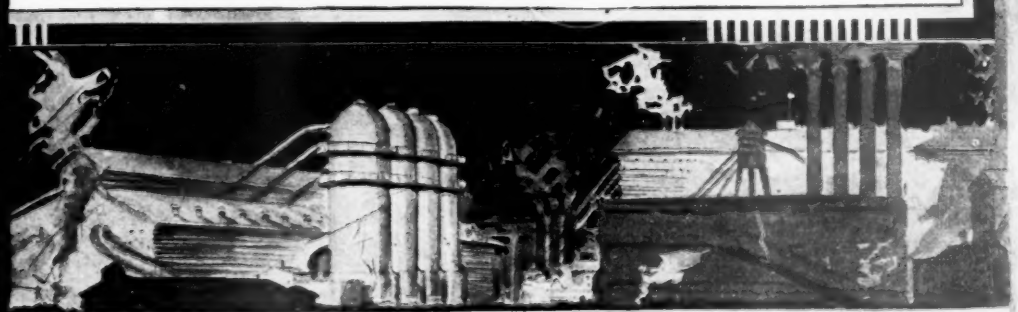

OXY-ACETYLENE WELDING *of* COPPER, BRASSES *and* BRONZES—VI.

By M. R. Amedo

Metallurgical Engineer to the Union de la Soudure Autogene. Translated, with additions by D. Richardson, Wh. Exh., A. M. I., Mechanical Engineer, Member of the Union de la Soudure Autogene

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The Welding Metal for Bronze

The welding rod to be used when welding bronzes should therefore contain a definite percentage of phosphorus and *very small traces of aluminum*. The welding rod should only be used in the cast form and its manufacture should be very carefully supervised, especially in the case of the alloys containing the higher percentages of tin. The temperature at which the welding rod is cast is also of very great importance in obtaining a uniform and homogeneous metal.

It has just been stated that the filling material should be in the cast form, and welders should know that the "bronze" wires frequently sold for the welding of bronzes are generally ordinary brass containing about 60 per cent of copper. The use of wire of this class for welding bronze gives results distinctly inferior to those obtained by brazing.

It is not possible to wiredraw bronze when the percentage of tin is above 8 per cent, and it is impossible to obtain wire containing much higher percentages than this. The only bronze wires to be obtained commercially are those containing from

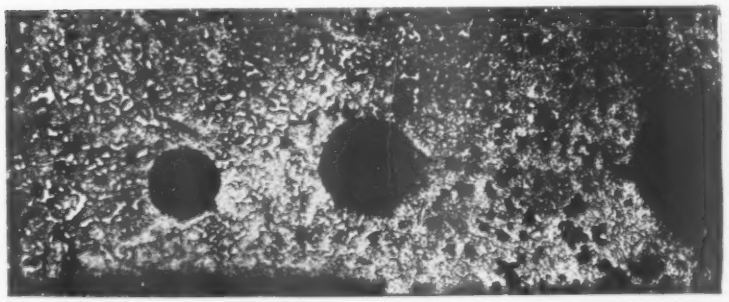


Fig. 29.—Building up a bronze bearing. The loss of tin in the central zone is where the material is added. Magnified 50 diameters.

3 to 4 per cent of tin, and it is obvious that the use of such a material for repairing say a very hard bronze casting containing 16 per cent of tin can only give unsatisfactory results.

An excess of phosphorus in the welding rod is not a disadvantage in the case of bronze; on the contrary it is an advantage to leave traces of phosphorus in the welded parts so that welding rods richer in phosphorus than other filling alloys are obtainable for work of the type of repair to gear wheels, etc.

The Superficial Loss of Tin Preceding Welding.

In a series of experiments in the welding of bronzes, we have discovered a very interesting phenomenon produced before the bronze enters freely into fusion: this phenomenon is the superficial loss in tin which precedes the melting of the edges of the weld.

If the whtie cone of the flame is applied directly on the edges of the welds, it will be noticed as the bronze becomes heated, and especially if the bronze is rich in tin, that brilliant globules collect on the surface of the metal similar to the molten drops of lead produced by the white cone of the oxy-acetylene blowpipe.

This phenomenon, which becomes very distinct when the bronze reaches a temperature in the neighborhood of 1,200° F. (650° C.), continues until the alloy melts freely. It may be prolonged for a long time by using a blowpipe much too feeble for melting normally the thickness dealt with.

In this case, as soon as the bronze is at a red heat, the brilliant globules remain on the surface of the metal for a very long time, the surface of the metal remaining solid. These globules of molten metal are some times volatilized by the blowpipe and leave on the surface of the metal traces of slag.

Fig. 27.—Surface loss of tin in a bronze welded by the blowpipe without preheating. (Magnified 50 diameters.)

Again, if a microscopic examination is made of a bronze from the surface of which beads or globules have been observed to disappear, it will be found that the constituent of the alloy rich in tin has disappeared from the surface.

Before the melting of bronze takes place there is a veritable segregation, which impoverishes the tin in the superficial zone of the alloy. This latter, as a result always has very distinct cavities.

The micrograph shown in Fig. 27 represents the surface neighborhood of a weld on bronze, after preparation and etching with an acid solution of ferric chloride. This etching colors white the constituent rich in tin. Note that the dimensions of the elements of this constituent diminish in proportion as the

surface is approached and finish by disappearing entirely. Hardness tests also demonstrate that the hardness of the metal decreases in a striking manner in the neighborhood of a surface wrongly attacked by the blowpipe. The decreasing hardness near the surface, and clearly shown in Fig. 28, indicates a loss of tin by segregation. This constituent rich in tin is replaced by blowholes.

We have made a series of tests on worn bronze bearings built up by the blowpipe. On breaking these bearings across the built-up portions this superficial segregation is very often clearly seen. In fact, below the face attacked by the blowpipe, the reddish color of the break indicates a lowering in the percentage of tin. It follows that a weld, or a building up of bronze, done without proper precautions consists of three parts —the portion of the article which has not been altered by the passage of the blowpipe; a zone impoverished in tin, a layer of unsound metal; lastly, the added material which may be quite sound.

The micrograph shown in Fig. 29 represents a built up bronze bearing of the type just mentioned. The face attacked by the blowpipe is in the center of the figure, and although the surfaces of the metal have been very carefully cleaned by

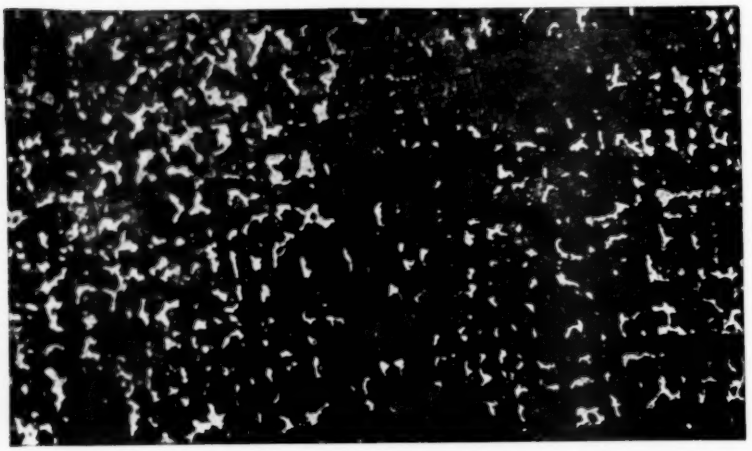


Fig. 28.—Decreasing hardness due to superficial loss of tin. Magnified 50 diameters.

the use of a good flux, it is clear that the percentage of tin in this region is less than that in the original metal or in the added metal.

It is important to remember that this segregation of tin can be entirely avoided by uniformly preheating with the flame of the blowpipe and by reducing to a minimum the interval in starting to weld.

Tempering and Annealing Bronzes

The annealing of bronzes gives them a uniform constitution, but considerably increases the hardness of the metal. On the other hand, the tempering of bronzes in cold water ameliorates very clearly the mechanical properties of the alloy.

But if it is a question of recharging worn bearings, the tempering in cold water, preceded by a reheating, enables the temperature of the whole article to be rendered uniform. Plunging a bearing into cold water immediately after repair, knowing that the bronzes are not such good conductors of heat as copper, means that only the part rebuilt is submitted to the effects of tempering. This produces a softening effect, whilst the remainder of the piece which has not been re-heated to a temperature sufficient for tempering, retains on the contrary its hardness.

In every case we recommend the uniform annealing of bronze parts, and the tempering after annealing wherever this is possible, for giving homogeneity. It is also very advisable to submit to these treatment bells repaired by welding, the original tone being obtained by the correct reheating.

Execution of Bronze Welds. Preparation of Parts

The edges to be joined should be bevelled in the same manner as that indicated for welding brass, and should be carefully cleaned. In order to avoid the collapse of the metal as it nears its melting point, it is very important, wherever possible, to support the lines of welding and their immediate neighborhood.

It is also necessary to avoid moving large bronze articles after they have been preheated. Articles that have been preheated should be moved with the same care as is necessary when dealing with aluminum castings that have been preheated before welding.

In welding bronze the part to be welded should never project or overhang because the low tenacity of the metal when near the melting point will produce, under the simple effect of gravity, the collapse of the whole of the heated portion.

Power of Blowpipe

The size of blowpipe to use is the same as that which should be used for welding brasses.

Execution of the Weld

Where the articles to be welded have not been uniformly preheated it is necessary to heat the surrounding portions of the weld, taking care not to bring the white cone of the flame too near the surface of the metal. A too great a localization of the heat leads to the segregation of the tin, as previously explained.

The neighborhood of the weld being at a red heat, heat the welding rod in the zone of the flame and coat with a thin layer of flux, then by bringing the white cone briskly to the surface of the piece, produce simultaneous melting of the welding rod and the piece. Throughout the whole of the welding operation care must be taken not to allow the white cone to come into contact with the molten metal.

Before commencing to weld, the bevelled faces should be cleaned, by means of a metallic brush, of cinders and scale which tend to accumulate during preheating.

The welding rod and flux should be applied very regularily, so that the reducing agents which they contain can be diffused throughout the molten metal.

The welds should be executed rapidly and should not be remelted without a new addition of welding rod and flux.

The welds on bronze are generally of a short length so that the effects of contraction are practically negligible.

Flux

To obtain sound welds a flux is indispensable. The flux used in the welding of brasses also gives excellent results in cleaning the surfaces and producing sound joints on bronzes. It is only necessary to dip the welding rod, from time to time, in the flux, to obtain a molten bath perfectly sound.

Treatment After Welding

Certain welders hammer bronze pieces after repair. We consider this operation injurious because, although the hammering increases the hardness of the alloy, it gives it a very high fragility.

It is good to submit the articles to annealing, followed or not by tempering, according to whether the work is required to be hard or, on the contrary, soft.

Applications

Oxy-acetylene welds on bronze executed in a proper manner and with the correct filling materials are highly satisfactory. The repair of bells has been successfully developed and the method of carrying out such repairs will be of interest. If the crack has developed as the result of the shock of the clapper, the repair, as a reule, is a simple one, because the crack extends down to the edge of the bell. If, on the other hand, cracks are set up as a result of the degradation of the metal,

...e cracks usually radiate in the body and consequently are more difficult to repair.

More commonly the repair is of the former type and the method of procedure is as follows: "The crack is bevelled in the usual way and any further extension into the body is prevented by drilling a hole beyond (about ¼ inch) and in the direction of the crack.

By means of a chisel or file the edges of the weld are cleaned. The bell is next heated on a fire (charcoal fire by preference) to a red heat, the bell being arranged so that the welding operation can be carried out without displacing it.

The operation of welding is carried out with a blowpipe sufficiently powerful to weld rapidly, taking care not to allow the white cone of the flame to come into contact with the metal and avoiding re-melting. The line of welding is slightly surcharged because the surface sometimes shows small blowholes.

The bell should be allowed to cool as slowly as possible and the weld after cleaning up should not be visible.

If the repair is carried out on these lines, the sonorousness of the bell as when new is obtained, and if the same tone is required as when new, this can be obtained by a re-heating followed by tempering in cold water.

The Welding of Aluminum Bronzes

So-called "aluminium bronzes" are alloys of copper with aluminium, in which the former metal preponderates. The alloys containing 10 per cent of aluminium downwards are those generally manufactured, and of these the 10 per cent alloy is perhaps the best for all-round properties. This alloy is extremely resistant to sea water corrosion and alloys of this type can be exposed to a red heat in an oxidizing atmosphere for several days without becoming appreciably tarnished by oxidization.

These bronzes can be welded perfectly by the blowpipe. It is only necessary to use an energetic flux of the nature of the one used in the welding of aluminium, and a welding rod of practically the same composition as the material to be welded.

SOLDERING REPAIRS ON NEW AUTO PARTS.

F. E. Totten.

This article is contributed in the hope of dispelling a somewhat widespread illusion that new cars have never heard of a welding shop and that the use of the oxy-acetylene blowpipe is confined to garages and repair shops. Also in the hope that the information herein contained may be of benefit to others of the profession.

I do not believe that a welder should confine his practice to welding alone, but rather he should know every phase of the repair and "putting on" arts.

The writer at one time was foreman of the welding and soldering department of one of the largest auto parts factories in the world, and this article will relate a few instances of soft and aluminum soldering that was very important, because of the savings affected and because the company was enabled to keep up with its production schedule.

In this day of intensive production and picce-work the operator of the particular machine he is running has the one thought uppermost in his mind, that of boring as many holes or milling as many surfaces or tettle as possible a day.

As an inevitable result, tools are allowed to get dull, pieces are put in the jigs the wrong way or are insecurely clamped in them, with the result that bearings are too large or are not in the proper relation to the other holes, surfaces are milled too low and teeth on pinions are "butchered" up.

The writer could go on indefinitely citing instances where mistakes are made which would become monotonous.

When any of the above mentioned mistakes occur the piece is worth just its weight as junk unless some method is devised that will reclaim it and make a salable article out of it.

On one important instance a change was made in the design of a small planetary transmission such as is used on cycle cars which provided for additional metal to provide for a return oil tube, that is, return the oil that passed from the gear housing proper to the bearing, back from the bearing to the gears again. See Fig. 1.

There had been several thousand of these housings made and they were ready to assemble the gears in them when the change in the design was announced. To have thrown these in the junk heap would have meant an enormous loss.

These were unusually thin castings and having all the machine work finished preheating and welding was out of the question, because to have handled slowly enough to prevent warping would have been too slow to keep up with the production schedule.

Accordingly the same day the change was announced the mechanical engineer brought me a housing with a copper tube extending from the shaft bearing to the gear housing and requested me to solder the tube as indicated in Fig. 2.

Soldering cast iron is no easy job by the old method so I sat down and proceeded to use my "think-tank." You see I am something of a chemist myself.

This is the "dope" I prepared and its success was highly gratifying.

Dissolve all the copper-sulphate crystals in a half-pint of distilled water that is possible, filter, and drop by drop enough concentrated hydrochloric acid to give the mixture a slight greenish tinge; warming the distilled water slightly will hasten the action of dissolving the crystals.

I then cleaned the cast iron around the holes through which the small copper tube projected and taking a small flat stick I dipped it into my mixture and a few drops adhering to the stick I commenced to rub it gently over the newly cleaned place and slowly a fine copper coat appeared. As soon as it was coated with the copper deposit to my satisfaction I immediately washed off the remaining liquid. It is very important that this be done **at once**, and the water must be clean.

The cast iron surface where the deposit is to be laid must be clean and bright. Keep your fingers off it, because the sweat or oil of one's fingers will form a thin coat of oil on it and prevent the deposit.

After the casting is coppered and washed thoroughly rub it with the finger and if the copper plating does not rub off you can rest assured it is all right. If it does rub off your casting was dirty.

I then heated a large soldering copper and tinned the coppered surface just as though the whole casting were made of copper.

A mild gas flame such as a Bunsen burner or a small Prest-O-Lite torch can be used very successfully by holding the flame underneath the coppered surface. Holding the flame directly in contact with the copper deposit will burn it so it will be of little value owing to the rapid oxidation of the heated copper film.

When the plating or coppered surface has once been "tinned" or has a thin coat of solder on it ("half and half") or better still, two-and-one solder (two parts tin and one part lead) it may be heated to a red heat without injury.

Aluminum solder may also be added to the tinned surface of the copper deposit and it makes a very good joint. Pieces of aluminum and cast iron may be sweated together with ease. Pieces of steel and copper, etc., that are easily soldered without the copper deposit preparation can be also sweated to pieces of aluminum.

Another instance of savings effected by the soldering plant of an up-to-date concern can be illustrated by the following:

A large number of differential cases made of malleable iron had one bearing hole bored too large and went through inspection until the final inspection caught them.

As they were finished and being made of malleable iron the

application of sufficient heat to weld them would have distorted them until they would have been useless; .002 to .004 is all the disalignment permissible. I scraped the too large bearings and then went over them with fine emery cloth. After that I copper plated the surface all over with the before described solution and then tinned them carefully with two-and-one solder. Then I melted a quantity of aluminum solder enough to make it plastic and, directing my flame directly on the tinned surface, I spread the aluminum solder on in a thin coat, much as a layer of babbitt. It goes without saying that the tinning must be thoroughly melted, as must likewise be the aluminum solder, so the two solders will cohere.

The bearing holes were then bored to the proper size, leaving a thin coat of solder all around the inside of the hole. As the solder is very hard for a solder, at the same time tough and springy, it made a very satisfactory job. This was done four years ago and has not been returned on account of the solder.

Aluminum solder plays about as important a part as any substance devised for the repair of aluminum castings. I think I am safe in saying that it plays a more important part than the oxy-acetylene flame.

Look at a transmission or crank case of a high class car and the uses to which solder can be used are many. Large or misplaced bearing holes, threads stripped in cap screw holes, and the numerous surfaces that are milled too low can all be built up with solder, remachined and made as serviceable as if made entirely of aluminum. The repair man who reads this can rest assured that his work is not merely a makeshift or temporary repair system, but is every-day practice.

He will do well to lay in a large supply of solder and make a study of it until he has thoroughly mastered the art, for the possibilities of making mill profits from its use are almost numberless. The writer will not attempt to explain the proper method of soldering aluminum, as it was covered in the August *Welding Engineer*.

LARGE METAL AND CHEMICAL NTERESTS COMBINE BUSINESS UNDER NEW NAME.

Announcement is made that the business of both the Goldschmidt Detinning Company and the Goldschmidt Thermit Company will hereafter be conducted by the "Metal and Thermit Corporation" with general offices at 120 Broadway, New York. These two concerns have been practically combined for the last two years and have occupied joint offices at the above address. The combination, which is controlled exclusively by Americans, has now been put in more permanent form as it is felt that this will tend towards greater efficiency and co-ordination of effort.

The detinning department of the Metal Thermit and Thermit Corporation will carry on one of the largest industries of its kind in the world, i. e., the recovering of tin from tin scrap. Approximately 100,000 tons of tin scrap is treated yearly by this department and the recovery approximates the equivalent of 2,000 gross tons of metallic tin. The output of this branch of the corporation consists of pig tin of a quality equalling Straits tin, tetrachloride of tin and detinned billets. The latter being the iron scrap after the tin is removed, compressed into billets and used by iron and steel plants for remelting.

In regard to the Thermit department, this will continue the production and sale of Thermit welding materials and apparatus as well as the various carbonfree metals and alloys which are produced by the aluminothermic process. The process was first introduced in the United States in 1902 and since then the business has grown very fast, particularly in recent years when there has been a very large demand for the materials as well as the welding materials. In addition to its line of carbonfree metals and alloys, the company produces pure Tungsten Powder of high quality and in very considerable quantity. It is also selling agent for the output of a large plant in the middle West producing 50% electric furnace Ferro-Silicon.

The Thermit welding process is used by practically all the railroads in the United States and Canada for welding broken locomotive frames and other heavy sections. It is also used very extensively by the different steel mills for welding broken equipment, such as rolls, pinions, crank shafts, etc. In fact over 1,000,000 pounds of Thermit is used annually by these two industries alone. The process is extensively employed for the welding of rails for trolley lines, the welding of broken sternposts and rudder frames of steamships and for other welding operations too numerous to mention. The process is quite different from either oxy-acetylene or electric welding and is adapted to a much heavier class of work.

The Metal and Thermit Corporation operates four different plants located respectively in Jersey City, Chrome, N. J., Wyandotte, Mich. and East Chicago, Ind. The Chrome and East Chicago plants are devoted to the detinning industry; the Wyandotte plant to the production of liquid Chloride and the Jersey City plant to the Thermit products including welding materials, carbonfree metals and alloys and pure Tungsten powder. The Corporation operates branch offices and welding shops in Pittsburgh, Chicago, San Francisco and Toronto.

The following are the officers and Directors: W. T. Graham, Edgar L. Marston, Daniel C. Reid, F. S. Wheeler, Hubert E. Rogers, F. H. Hirschland, E. L. Ballard, L. A. Sellos, Chas. F. Dane, Philipp Consheimer, Fred W. Cohen.

NOVEL ADVERTISING STUNT

In connection with their exhibit at the recent Chicago Automobile Show, the Imperial Brass Mfg. Co. had an attractive feature in the form of a miniature welder, 15 inches high. The equipment was complete, including a torch, 6 inches long and a

3½ inch regulator. The acetylene tank was 8 inches high and the oxygen tank 12 inches. Gloves, goggles, apron, etc., completed the illusion. Red glass and an electric light were located under the gear in the preheating fire.

The display was designed by Mr. J. G. Pettis, engineer of the company. A jump spark from torch tip to gear wheel gave the little welder the appearance of activity.

Hints for the Welder

When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way—I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today—the men on the firing line are waiting.

L. B. Mackenzie, Editor.

THE CHURCH BELL AGAIN

Editor: We are in receipt of an inquiry this morning from one of our customers in North Dakota as follows:

"I have got a job of welding a church bell and I do not know just what kind of metal to use for welding it. The bell is a steel casting, as far as I can figure out, and as hard as glass. You cannot cut it at all. It is from 2 to 2½ inches thick. Kindly advise me what kind of a filler rod to use and oblige."

As we have not seen the job and never having had any experience with bells, we would deem it a favor if you will kindly enlighten us as to which in your opinion is the best filler rod to be used to retain the tone. Any and all information you can give us on this subject will be greatly appreciated. Manufacturer.

Answer: I note what your customer in North Dakota has to say, and about the best answer I can give you is to enclose a copy of an article which appeared in the January 1917 issue of *The Welding Engineer*, entitled "Reminiscences of a Welder." From reading the remarks of your customer, and noting what he has to say about the bell evidently being a "steel casting," I should judge that he had better proceed very cautiously. These bell jobs are very difficult, and if handled improperly may lead your customer into a lot of trouble. I therefore suggest that he study the article carefully. Editor.

MELTING TIPS

Editor: My tips burned off sideways. Do you know why this occurs? Is there any remedy or are there tips made that will stand the flow of gas or pressure when torch is placed against article to be welded?

J. L. Corbin.

Answer: Referring to you. inquiry regarding burning of tip when welding in a V-shaped depression.

Brass or tips low in copper will melt more easily of course than tips made of copper. Many manufacturers now use an all-copper tip, particularly on the larger drill sizes. Under some conditions, a copper tip will also melt. This can largely be prevented by proper manipulation of the torch. The V should be made wider, for instance, so that the heat arising from the weld has an opportunity to get by the tip. At no time should the tip be brought into contact with the metal as you show in your sketch, as it is most certainly bound to melt if you do this. Editor.

STEEL AUTO PARTS

Editor: I expect in the future to have a good deal of oxy-acetylene welding on automobile and auto truck parts, and woud like to know what is the best rods to use on the steel parts, axles, drive shafts, universal couplings, etc. I suppose these parts are different composition in the different makes, but I would not know what the composition or analysis of any of them would be, so I suppose I would want a rod that would do for all. W. A. Bennett.

Answer: The rod in customary use in shops doing this kind of work is known as 3 per cent nickel.

May we suggest that before you attempt the welding of drive shafts, you are very certain that you can make a good weld on steel of a lower carbon content. Editor.

CUTTING PIPE

Editor: We are endeavoring to cut by the oxy-acetylene process 1-inch pipe lengthwise. We are using a Dyer cutting torch, made by the G. H. Dyer Co., of Cambridge, Mass. We have this arranged so that we can vary the speed of the torch and of course the oxygen pressure.

Our trouble is that an oxide forms on the inside of the pipe at the bottom of the cut and leaves a ragged edge there. Can you suggest any way to get rid of this oxide which forms on the inside of the pipe and leave a good clean edge?

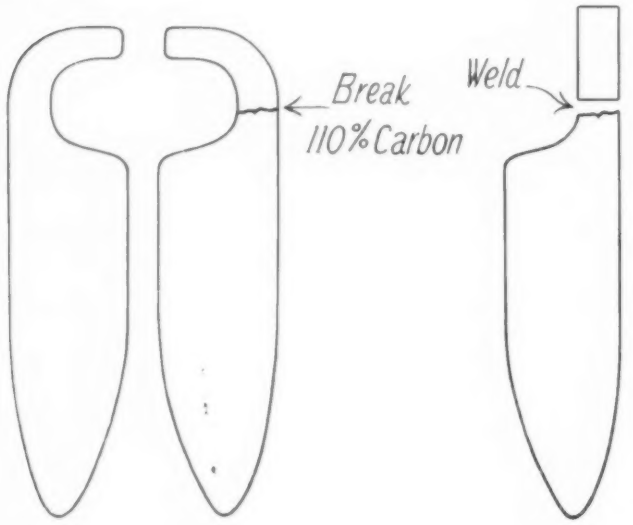
This is a manufacturing job, and it is necessary to do it as cheap as possible, and at the same time keep it looking well. Wilkins & Hovey.

Answer: Referring to your letter regarding cutting of gas pipe, we would advise that you take this matter up with the G. H. Dyer Co., the manufacturers of your cutting torch.

The wall of gas pipe is quite thin and from your description, we would say that the flame of the cutting torch is too large, resulting in partially melting the edges and depositing this on the underside of the cut. There must be an almost perfect co-ordination of size of flame, velocity of the cutting oxygen and speed of the torch to secure a cut on a thin material free from oxides; but we assure you that it can be done. We do not believe that you can personally do this, but by taking the matter up with the Dyer Co., they can probably make you a special tip for your cutting torch for this purpose. Editor

HIGH SPEED STEEL.

Editor: Being a reader of the Welding Engineer, I have tried all the methods seen in your paper and others regarding the welding of high speed steel and I am not satisfied yet with the results. The tools I have welded are 2 x ¾ inches and about 3 inches or 4 inches long, welded to a piece of machine steel about 7 inches or 8 inches long. The best results I have got so far are with vanadium rods 4 inches and silicate soda for a flux. The last tool I did I had it forged ready for grinding before welding and it is in use on a big planer but it will break when it is being forged over again. The breaks always occur about ½-inch below



the weld in the high speed steel. The trouble, as it seems to me, is that the tool needs some sort of treatment after welding. If you can give me some enlightenment on the subject I would be very much obliged. There is another pointer I would like to get in regard to tool steel 110 per cent carbon. In the shop where I work (The Hydraulic Pressed Steel Co.) we have a tractor service for hauling trucks and the tractor has an attachment for engaging the truck.

Now these draw bar forks are bad for breaking where I have marked it. I make the weld with a piece of 1-inch square steel of the same carbon con'ent, when the broker piece is lost, and leave it straight.

The blacksmith hammers it into shape, and the weld shows cracks on the corners after being shaped. Now what I want to know is, should tool steel be worked after being welded, as per sketch. I use drill rod and borax for welding.

J. M. Singer.

Answer: Vanadium rods are not bad for welding high speed steel to low carbon shanks, but try nickel steel rods and previous to welding build about a ⅛-inch surface on the high speed and then weld it to the low carbon.

The only special treatment that I know of is in the hardening and this should be done by a competent and experienced blacksmith. The best hardening is done with fish oil, and the heating in an electric furnace.

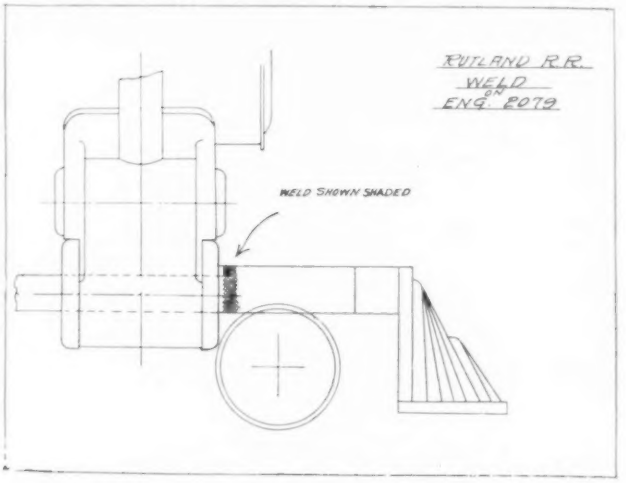
In regard to the broken draw bar forks I would advise to forge them previous to welding and then to cut them to the proper length and the weld can be made secure without exposing it to a severe strain.—Editor.

RAILWAY WORK

Editor: I enclose a couple of sketches of jobs which I have done in my three years' experience with the electric arc welding. I wish you would publish in *The Welding Engineer*.

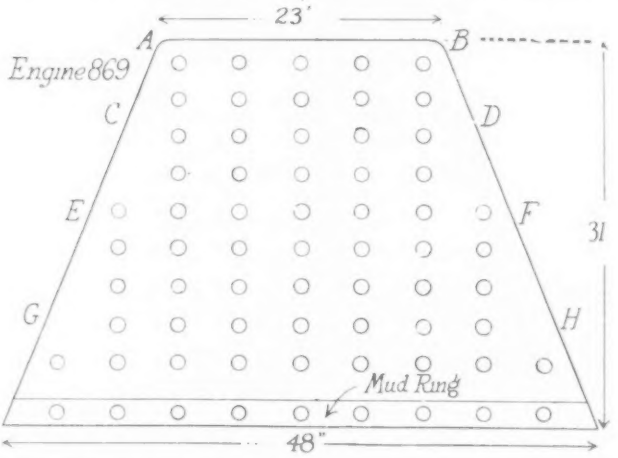
I wish the reader would notice the weld of this 5 by 11 locomotive frame which has been welded almost a year without any failure occuring.

The sketch of this patch has been welded about 16 months I welded in this fashion: Catch the top line at three or



four places, and weld until it is complete, then start about 1 inch below the corner and weld up around the corner—same at the other corner. Wait until the corners are cool and start at C up to A, from D up to C, from E up to C and so on until you have both sides done. Be sure to leave a little fullness in the patch so there will be no pulling on the weld--thus giving you a perfect job.

The longest crack I welded in a fire box was about 45 inches long on top of the back flue sheet in the heel of the flange in one of the high pressure boilers containing 400



2-inch flues. I welded it in the following manner: I welded about 1 inch to 9 or 10 inches in part. Then welded a couple of inches on one end, and will give the weld a chance to cool off on the other end.

Doing this until you ha e the entire crack welded. The flues were not disturbed at all but I had my helper in the fire box keeping the flues cooler with cold water and a piece of waste without having the water run in the weld while I was welding inside of the boiler. Since the crack has been welded the engine had a new set of flues in the shop and out again on service without any disturbance of the crack, thus showing good results.

I won't take any more of your space talking about flues, as some other welder has already done this, but I must say that I have had good luck since I started welding flues. I would like to mention a few set of flues which I welded without copper ferrule—just rolled and belted them without beating. The first one was welded March 15, 1916, and is in service ever since without any leaky flues.

Chas. A. Janetti.

WELDING CAST IRON BOILER SECTIONS.

Editor: One of the jobs often met with in the fall or winter in colder climates is the repair of cast iron heating boiler sections. These are cast hollow with walls about ⅜ inch thick. They are about 4 inches deep. The end sections are cast in one slab with only two openings in it while the center sections have a number of openings as shown in the sketch. On account of their shape and thin walls careful heat treatment is necessary.

The break in the casting shown was located at AB and ran through three faces, so by directing the flame of an oil burning torch at section CD and being careful to heat most at C we cracked it all the way through and opened the crack AB about ⅛ inch. The weld was then made at A, on what would be the flat horizontal surface of the fire door opening when the section is in position in the furnace, and down one side to B. The section welded was then put on a forge fire and heated to a red and CD were also kept at about the same heat as at first. Then the opposite side and bottom were welded on the fire. The casting was then

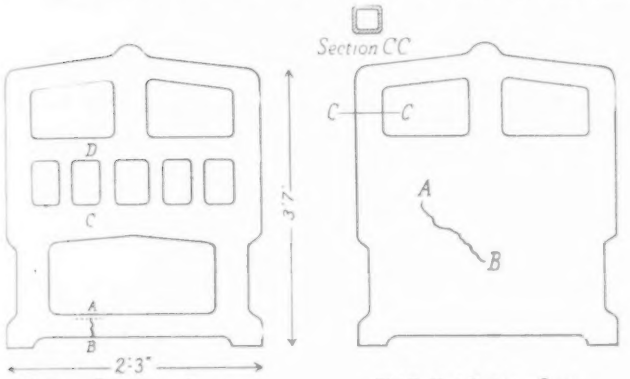


Fig 1 Radiator Section *Fig 2 End Radiator Section*

turned over with the newly welded surface down and heated to a red and then left to cool slowly on the fire. After cooling a small crack appeared at the dotted line across the weld. This face was again slowly heated a red and welded, then annealed.

The original crack may have been due to unequal contraction in the original casting or due to unequal heating in the furnace. The fact that it broke showed there was a stress there. By expanding it at CD we lengthened out the lower water leg so that it would remove their stress. The section has been in use several months since welding without giving trouble. It weighs about 350 lbs.

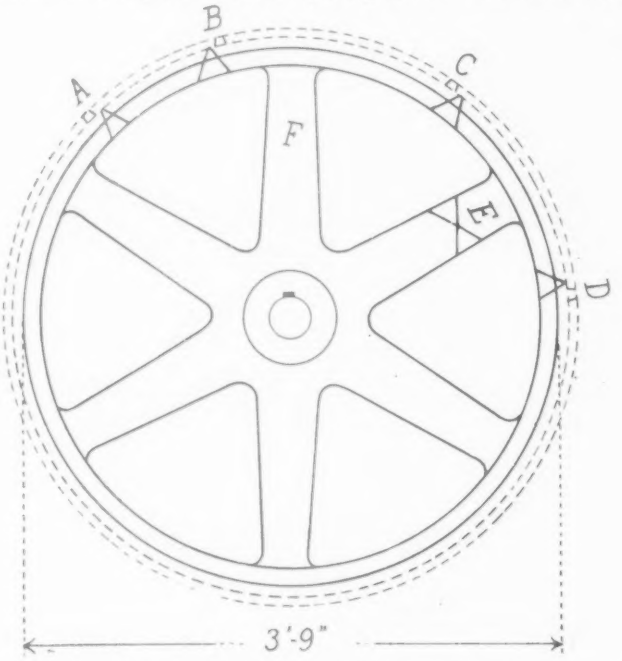
Figure 2 shows another section which required different treatment. The crack was located as indicated at AB. In this case a charcoal fire was built under it as indicated by the broken line and the charcoal heaped up on the sides and top. Some was also placed inside under the crack. It was covered and allowed to heat slowly on the fire and welded in place and then annealed by another charcoal fire.

P. W. Martin.

WELDING A HAY PRESS GEAR

Editor: Recently one of our customers brought in three large gears from a hay press, all of which had several teeth broken out. The best gear had eight teeth out at AB and eleven at CD. Instead of welding in new teeth we cut out sections, slanting the cut as indicated. From one of the other gears we cut out a section, CDE, but slanted the saw cuts the opposite way, so as to leave an opening for the weld. The same was done for AB. A piece of ¼x3 iron was then bent to the same radius as the outside of the gear and clamped across AB. The section was then clamped to this band and the spacing of the teeth at A made about 3/32 larger than the normal spacing and welded without preheating. Then the arms each side of AB were heated until the spacing at B was about 3/32 more than normal and the ends brought even. The weld was then made and on cooling, the spaces at A and B were found to be absolutely correct.

We then followed the same procedure on the piece CDE, making the weld at E first, allowing the same amount for contraction and then at D. Then the arms E and F were heated to bring the correct spacing at C. The band iron



was removed and when the two ends at C were even and the spacing just over 3/32, the weld was made. On cooling it was found that the gear was absolutely true and the spacing of the gear teeth was absolutely correct. The pitch of the teeth was 1 inch.

A new gear cost $50.00, and the whole welding job cost $18.00 and several days' time was saved in addition. To have built up each tooth would have cost much more and the job would not have been satisfactory.

P. W. Martin.

PROPER RODS

Editor: What is the proper kind of a steel rod to use to build up teeth in a steel master gear of an automobile? How would you suggest to harden them? What is the best steel to build on cams, something that will harden properly? I have used nickel steel in both, but the same does not harden properly and while the tooth holds O. K., the same wears out very quickly, on account of not proper hardening. D. W. Co.

Answer: Would suggest using a ⅛-inch drill rod for the building up of teeth on automobile gears, and have them hardened by any firm who does this class of work, for if you are not properly equipped for hardening steel you will have little or no success. Editor (4).

BOILER WELDING

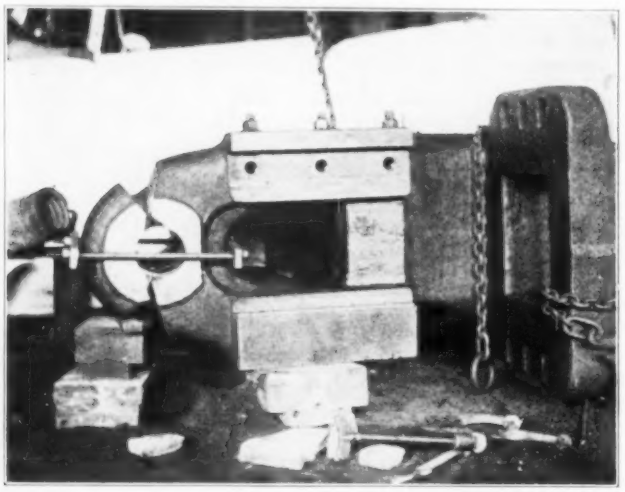
Editor: I find that the boiler Inspection Department of the various states will not permit a lot of repairs on boilers that can be done better by Welding than any other way. This, is, of course, due to the fact that there are not enough Welders who can make a reliable weld, so that any other course would be dangerous. As I have been a boiler maker

for the past 20 years, and have been using welding almost ever since its adoption in this country, I would like to give some of my experience along this line, from a practical standpoint. On a bad, leaky, cracked door hole, beyond calking, after most all of the rivet holes are cracked out, I find that it pays to cut the lap out and do away with that double thickness and butt-weld a patch in, making two welds around door hole. Make the large weld first, then heat and make edges come even, so the small weld can be made. I have 23 of these on steam shovel boilers and three of them are five years old and never a tool put on since, but I find to hire a man to do this side hand welding is quite a job. One trouble with most welders is that they want all their welding turned so that they can weld down handed. I wish every welder would spend ten minutes each day welding on side or overhead. I find that side welding is the easiest to do after a while. I turn all my plate work sideways in our shop, not caring to learn down hand welding. I cut out old laps and fitted new collars in about 3 or 4 hours and then it takes me 3 to 3½ hours to make a first weld, a little time to make edges even, and about 3 hours to make second weld, or about ten hours on job; and it is complete when I say this. Keep away from stay bolts as far as you can, so as to save the time to hammer them up again. The heat will make them leak.

Boiler Expert
Youngstown Welding Co.

OPPOSED TO PREHEATING ALUMINUM

Editor: I am sending you photographs of an aluminum crank case which I welded. The case was broken in thirteen pieces. I do not believe in preheating. All I do is to take my torch and heat the case (some welders would call it warming).

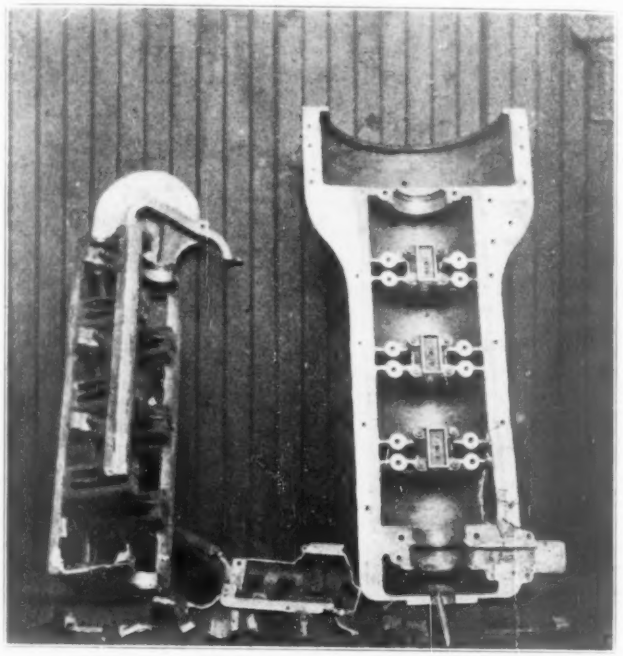


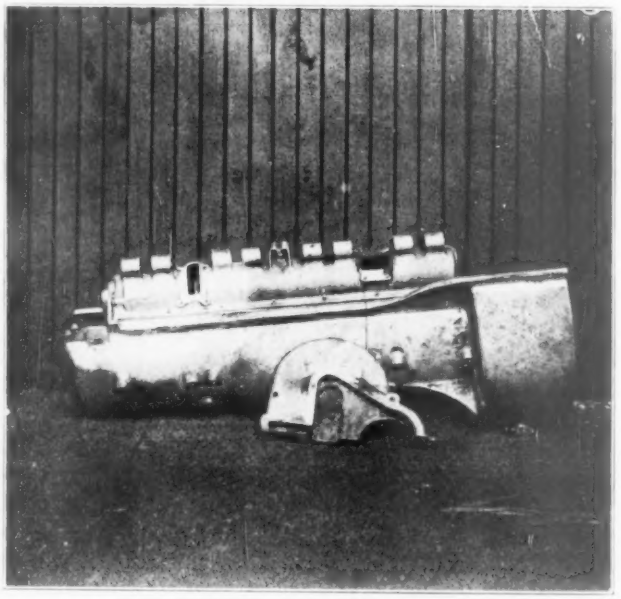
When you start working on aluminum never stop until finished, for if you do the case is sure to crack. Keep on your weld to the finish. I have welded hundreds of aluminum crank cases and never failed. I believe in working fast on aluminum.

I also enclose a photograph of a cast iron press, ready to weld. The crack was 9 inches in length and 8 inches in width and 8 inches in depth. I used a kerosene torch to keep it hot while I was welding. The press is now in operation. I used two torches, laying one aside as it became hot.

William Hall.

Editor's Comment: If the welder thoroughly understands the principles of contraction and expansion the welding of aluminium is a simple matter. It is quite possible to weld a cold, or semi-cold case and have the weld hold. In such cases, however, in determining the alignment, it will be found that the case is shorter on the welded side. It is not necessary to heat the entire case, but only that portion affected by the cooling area of the weld. The proper heat is quite a matter of individual judgment, but it should be a *slow heat*. Chapter 4 of





Dunham's "Automobile Welding" is about the best available information of which we know on this subject.

Mackenzie.

BIG CYLINDER JOB

Editor: We are sending you a photograph of a 66" Cylinder, Welded by the Youngstown Welding Company for the Brier Hill Steel Company of this City in December of 1916 and still in use.

On account of size and extent of the break, a brief discription may be of interest to your readers. The white marks show the general course of the break, a total of 32 feet of welding, varying from 2½" to 3½" in thickness. At the point marked W a wedge piece was broken out of flange weighing 75 lbs., also there were three bridges in the valve ports measuring 4x5 inches, cross section. After being re-

aired in the usual way Cylinder was set up on end and a brick furnace built all around it, which took 15 bricklayers and helpers one hour to lay up. Four turns were necessary to complete the job, the furnace being built up each time. The first fire was started Monday evening and the last weld was made the following Sunday morning. About one-third of the time was consumed in actual welding. After being welded it was taken to the machine shop, the high spots taken off, counter bore and the flange faced. The main bore was found to be out 1-64", which could be accounted for by the wear of the Cylinder. The engine was

out of commission two weeks, a new cylinder being ordered at the time but not delivered until six weeks later.

900 bushel charcoal was used in preheating, 500 pounds of cast iron, 5 rolls of asbestos paper, 22 tanks acetylene and 33 tanks oxygen. Youngstown Welding Co.

INTERESTING PIPE JOB

Editor: In one of your recent issues, one of your subscribers made the complaint, that the welders throughout the

country did not publish enough pictures of their plate welding work that was done in their shops.

We are sending you under separate cover a picture of a welding job done in our shop last summer for a hydraulic dredge boat. The pipe is 16" in diameter, 5/16 plate, the top portion of it is a ninety degree ell. The pipe then had an offset of two, forty-five degree ells, and one more forty-five degree ells on the bottom. We also had the contract for 1600 feet of straight steel pipe, eighty, ninety degree ells, four forty-five degree ells and one forty-five degree Y. We had only twenty days from the time that we received the material to the date of delivery.

After receiving the material we saw that we could not complete the job in time by riveting, so we decided that we would rivet the longitudinal seams and weld the circumferential seams, and we found that the welding was cheaper and quicker than riveting. We saved about 2" pipe and also the rivets and made a much better job, the pipe being smooth inside.

After we had so much success welding the straight pipe we decided to weld all the elbows and the picture we are sending is of the most crooked one of all.

The discharge pipe on the dredge boat came out at right angles of the hull and projected a little out over the boat ten feet above the deck. The engineer in charge of the dredge wanted the discharge pipe to come back onto the boat, down to the deck and follow the sheer of the boat. We had no trouble to make the pipe to fit the place. You will see on close inspection that we riveted the flanges.

We are at the present time welding a 30" pipe, that has a return bend in it on six foot centers and the other end is a bell shaped with a small flange on it and a thirty inch opening on the side. This pipe is to be used for vacuum pipe and we had to guarantee it to be absolutely air tight, so we decided to weld it.

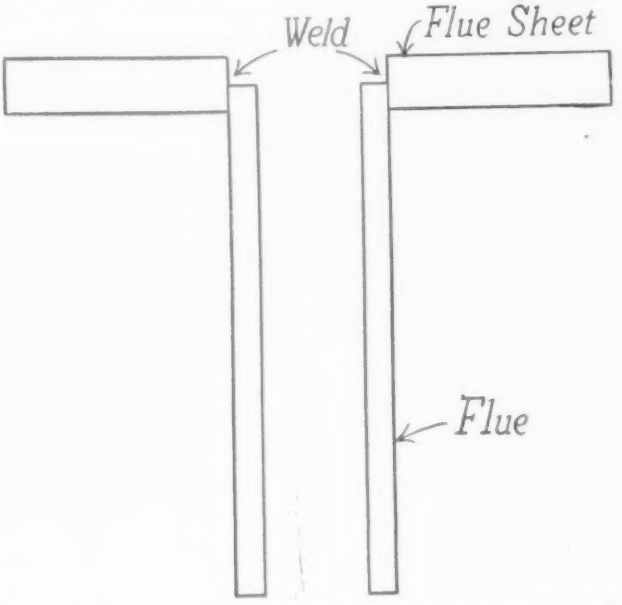
We are sorry that we are not able to give you the cost on this work as our welder is continually jumping off the big job to weld some rush job, but we are satisfied that it is better and cheaper than the old way of riveting.

Greenville Boiler & Machine Works.

FLUE WELDING

Editor: I would like to know the best way of oxy-acetylene flue welding. E. J. Bock.

Answer: The enclosed sketch shows the methods employed for the welding of flues, the distance from the top of flue to the face



of sheet should be the same as thickness of flue, welding being very carefully done as an oxidized or carbonized weld won't last long in locomotive, due to the great amount of vibration.

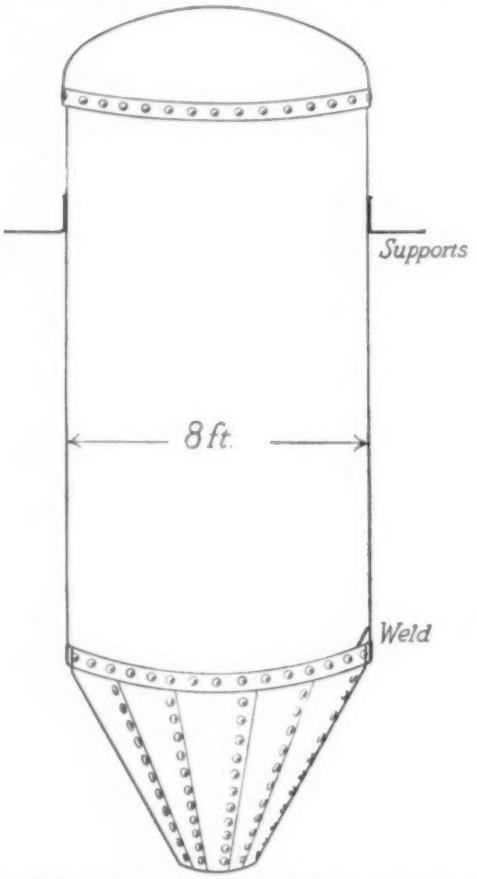
When wedling flues it is good practice to weld one flue on ride side of sheet, then weld the next one on left side of sheet, then weld one at top, and so on. The reason for this is to distribute the heat as much as possible over entire sheet, so as to eliminate the possibility of cracked bridge. Editor.

A TANK HEAD

Editor: Can a job like this be welded, an if so how would you go about it? Can the bottom be welded to the tank by making a lap weld, with the rivets in, welding rivet heads at same time?

H. H.

Answer: We see no reason why the bottom of tank can-



not be welded (lap weld), the rivets to be included and make a part of the weld. We have no knowledge of what this tank is to be used for, but under ordinary conditions we would say that this form of construction is not most desirable. We do not refer to weld, but to shape of tank.

Editor. (1)

WELDING ALUMINUM

Editor: Will you please give me some advice as to the welding of aluminum, that is, crank cases, etc. How is the best way to preheat same and also what is the best way to test weld to find the proper heat to be welded. What kind of flame should be used.

Also advise me as to the best way of keeping small cast iron parts from getting hard after welding; that is, parts that do not need preheating but must be machined after welding.

What is the best kind of welding rod to be used on cast steel?

A. W. Davis.

Answer: In answer to your first question would suggest you look up *The Welding Engineer* for March and April, 1916, as this question is thoroughly gone into and much valuable information given that will surely help you.

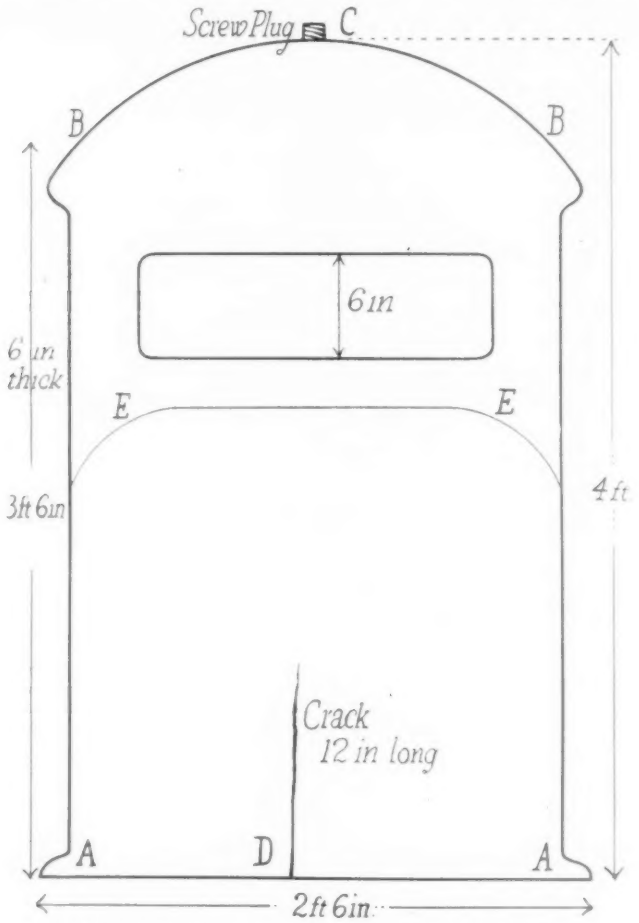
When welds on small castings get hard, as you describe, it is caused by too sudden cooling and can be overcome by heating casting about 1½ inches on each side of weld when finished and then cover casting with small piece of asbestos to allow it to cool slowly.

Norway iron is about the best rod to use on cast steel.

Editor.

LARGE CASTING

Editor: Enclosed you will find a rough sketch of a cast iron casting brought in to me the other day for welding. Dimensions of casting are as follows: Six inches thick. Distance from A to



B three feet six inches. C to D four feet with screw plug in top at 6. Opening right across casting to about four inches on each side toward top of casting is six inches wide. A to E is dish in casting about four inches deep. Distance across casting about two feet six inches. At bottom of casting it has been welded before from one corner to the other. Crack is twelve inches long extending from bottom towards center. Cracked right round on both sides. Was asked if I could weld it. I told them I could. Told them it would be about thirty-six hours before they would get it. I was going to "V" out crack to bottom, think casting was hollow in center as it belonged to a heating furnace at the depot here. Build a furnace of loose bricks around it, about one brick above casting, cover it with charcoal and set fire to charcoal and let it lay there until nicely red and then clear charcoal again and lay sheets of asbestos over it until cool. If hollow in center suppose I would have had to turn it over. Please tell me best way to handle this as I am not very long at the welding and never had any castings like this before. Am working with an Oxweld outfit in Great Northern Round House at Willmar, and will be glad of any advice you can give me on any subject.

D .C. Watterston.

Answer: The casting you describe is a section of a heating furnace, the thickness is about ⅜ in. and is hollow inside. The best method of welding this job is to chip crack to a 45 degree angle, then set casting on two fire bricks resting on four places, build brick all around about four high, and cover with charcoal both top and bottom, and after good and red will be ready to weld, then cover up good with asbestos paper and allow to cool very slowly.

Editor.

COMPRESSING GASES

Editor: I am a subscriber to *The Welding Engineer* and cannot praise it too highly, having taken a great interest in some of the discussions, especially those relating to refrigeration. As I am affiliated with that part of the trade, I wish to endorse Mr. Keith Dunham, the more so as I know some of the men who are downing the game.

If you have at hand; and know where I can obtain the following information, I would be very grateful for your assistance. I wish to know something of the compression of different gases; for instance, if I had coal gas, how high would I have to compress it to put two hundred feet into one foot of space? Will it compress without disassociation? Is there a regular formula for the compression of gases in the relation of volume to pressure and do all gases hold true to this rule? Please give me data on two or three combustible gases, or tell me where it can be most readily found. Harry Ross.

Answer: This is rather a difficult subject on which to advise you, as there are many things to learn before any gas can be safely compressed. We suggest that you go to any large public library and you can there find quite a large number of books pertaining to gases and their peculiar qualities.

We see no reason why ordinary coal gas cannot be compressed to a high state without danger, provided you can secure a container sufficiently strong to hold it. To compress 200 cu. ft. into 1 cu. ft. of space, roughly speaking, would require 200 atmospheres or approximately 3,000 lb. pressure per square inch. In a general way, this would hold true of all gases, provided liquefaction did not take place before the maximum pressure was reached. Acetylene, for instance, would liquefy at about 600 lb. pressure and become violently explosive. You will understand that temperature and altitude govern this general rule. We are merely speaking in rough terms.

Referring to that part of your letter, asking for data on two or three combustible gases. We cannot answer this as the question is too vague, but if you will specify about what combustible gas you want information, we shall be glad to tell you what we know.

Making a wild stab at your questions, we guess that you are attempting to get data pertaining to compression of combustible gases with a view of using it for motive power for mobile purposes. If this is your plan, we can say to you that some of the best minds in the country are working on this and so far have not been at all successful, so there is plenty of field for you. Editor (3).

STEEL WHEEL.

Editor: Enclosed find a sketch of a steel break drum or wheel. I have made it as near to the exact size as possible. I have had several of these wheels to weld in the past few months and they must be welded in position and as far as I know we have always done so, it being a very hard job to tear the line apart to get it off. This wheel was broken at D E, and F E and F were only open from the outer edge to a little past the center, but D being broken the full width and cracked down the body of the wheel to near the center of the rim and hub. With the drums in position it is impossible to weld the break at D from underneath the rim toward the hub. We always had orders to just weld the rim and leave the crack underneath go. Have welded several like D successfully. But this was the first I had with three breaks. Some time ago I welded this wheel and today I was called over to weld it again and it was the same break and by a close examination I notice it did not break at exactly the same place, but about a half inch from the position of the last break. I prepared the break for welding and started welding. I noticed the break at D from G to H was about ⅛ or ¾ open. When I was nearly through the break from G to H was closed as tight as it could get. It appeared to me as though that should have opened further instead of contracting. It appears to me that while the rim is expanded and that looks as if it contracted, something must surely give when it gets cold and the rim contracts.

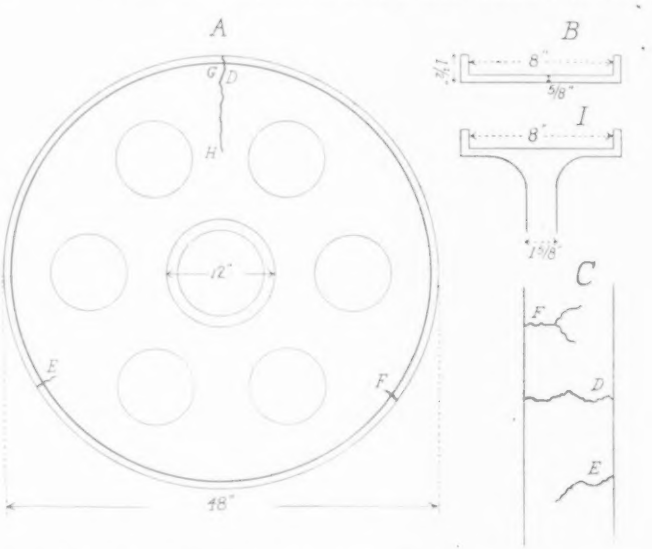
Do you think that drum should have been taken off and preheated? We had to confine all the heat to the rim and drum and not let any of the surrounding parts get heated. I would like to hear if you could give me information on the cause of the action of that metal.

A is the drum. B, rim of drum. C, the face showing the breaks; D, E, F, showing position of breaks. I, shows metal uniting rim and body to hub.

I will appreciate your advice.

R. Ochenreider.

Answer: We agree with you that it is difficult to weld a job of this character in place, but it is not practical to dis-



assemble the equipment to get at the wheel. We realize you must do the best you can under the circumstances.

May we suggest when welding a break of any kind it is well to bear in mind always to work towards the opening and not start at the opening and work towards the end of the break?

In welding the rim, as you did, it would have been better had you inserted a wedge in the line from G to H and opened the rim as D, made the weld and then removed the wedge, allowing it to cool. Bear in mind that metal contracts when cooling and that when you welded the rim as you did, there was not sufficient opportunity for the weld to contract properly and there must have been tension at this point.

The fact that you were not able to weld the entire break will always mitigate against your being successful. If you can possibly do so, by all means weld all the break and if any other opportunities are in the way, make a weld from H to G in a vertical position, if necessary.—Editor.

HEAT PRODUCTION IN ELECTRIC ARC.

Editor: In your December issue, there is an article on Heat Production in the *Electric Arc*, in which some results of tensile tests are given, and some conclusions drawn. There seem to me some discrepancies in the conclusions and results, which I shall mention, and I should appreciate it if these matters can be made clear.

The first conclusion states: "That the current did not affect the strength." It does not say whether the strength of the weld or of the original material is referred to; but, in conclusion three, it is stated that the current *did* affect

the strength, because with low currents the breaks were in the weld, and with high currents, giving better penetration, the breaks were outside of the weld. Therefore, if the third conclusion is correct, the first one is incomplete.

Conclusion two states that in type A tests (full bevel) all of the test pieces broke outside of the weld. The photograph shows that test piece 3 broke between the white lines, which would appear to be in the weld. All the other pieces stated to have broken in the welds, broke between these white lines. What is the explanation of this seeming indifference?

I do not think conclusion three is entirely justifiable—in the type B tests, the piece welded at 80 amperes broke *in the weld* at 57,590 pounds, while the piece welded at 110 and 120 amperes broke *in the original material* at 49,650 and 51,980 pounds, respectively. What conclusion as to the strength of the **welds** can be drawn from this, and how can comparisons of value be made between a strong **weld** and a weaker original material? Evidently nothing is known as to the strength of the **welds** in the last two cases.

I believe type C is considered the poorest way to prepare pieces for welding. If so, why does this type test piece, at 110 amperes, give 52,800 pounds, breaking in the weld, while type B, a better method of preparing, give only 43,830 pounds at the same amperage, also breaking in the weld? Also, why does the type C piece, at 100 amperes, show greater strength (57,270 pounds, and the weld was stronger than this) than either types A or B at 100 amperes (54,680 and 40,790 pounds, respectively)?

It should be noted that the pieces that broke in the original material varied in strength from 49,650 to 59,770 pounds, (test pieces 11 and 4). Why should there be such a great difference?

In type B, pieces 7 and 8, (80 and 90 amperes) give an average strength of 54,500 pounds, while pieces 9 and 10 (100 and 110 amperes) give an average of 42,300 a difference of 22%. Why did they all break in the welds.

Type C weld, at 100 amperes, had a greater strength than 57,270 pounds, because it broke in the original material. Type B, at 100 amperes, broke at 40,790, in the weld. At 90 amperes, the conditions are reversed, type C breaking at 40,690 and type B at 57,440. The latter three all broke in the weld Is it possible that the difference of 10 amperes caused this? If not, what is the explanation?

The only answer I see to these questions is that the soundness of the welds varied greatly, and that probably the original material was not the same all the way through, though this last cannot be stated positively. Of course, under either or both conditions, no comparisons of value can be drawn. I have examined carefully so many welds, and found so few anywhere nearly sound, that the above explanation seems to me perfectly reasonable. I believe that, unless a much more thorough examination of welds is made, so that the imperfections may be eliminated, and sound welds produced, it is useless to make comparative tests.

Sound welds can be produced, I believe, by the electric process. I know they can be by the oxy-acetylene, but attention is needed to details that are frequently overlooked or thought to be of no value. It is undoubtedly true that the same attention to details will produce better results in electric arc welding.

These critical examinations of welds have not been generally made in the past, because they have not been deemed necessary; but it is necessary now to make such investigations, and the sooner it is done, and the facts determined, the better for all of us.

S. W. Miller.

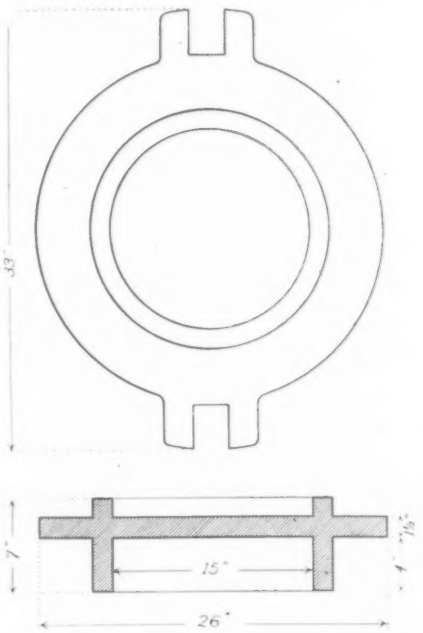
A PRACTICAL TEST OF CAST STEEL WELDING

Editor: An interesting practical test of cast steel welding was recently made at the yards of the Chester Shipbuilding Company, Chester, Pa. Right in the midst of construction of a dock where piles were being driven night and day, one of the pile caps broke in half through the middle.

It was chipped out from both sides and welded together with the electric arc, and special soft steel welding wire.

The electric arc was supplied from a special generator which furnished automatically controlled current, and the voltage on the arc was limited, by means of an automatic device, no preheating was used.

Section and plan of the pile cap are shown in the accompanying illustration. The cap weighed approximately 800 pounds and cost $78.00 when new. The complete operation of welding consumed 12 hours of one welder and helper.



The cap was put into service immediately, driving piles inclined to the horizontal at an angle from 50 to 60 degrees, receiving blows from a 3000 lb. hammer, falling approximately 30 feet. At the time of this writing, this cap has been in continuous service for over two weeks, and no signs of failure had developed. This remarkable performance demonstrates, that there could have been no appreciable crystallization of the metal, either in the weld or adjacent thereto, otherwise it could never have stood continuous pounding which it has been subjected to.

Otis Allen Kenyon.

DOES STRIKING THE ARC INJURE THE MATERIAL?

At various times statements have been made concerning the change in the character of iron or steel after an electric arc has been struck. It has been claimed that directly under this point the material undergoes a change resulting in a poor quality of metal which is simlar to burned material. This inferior part is supposed to be in the shape of a cone with the apex downward. These statements have, without exception, been made by men who are associated with the oxy-acetylene industry or by arc welding representatives who manufacture or handle an arc welding equipment which is designed to automatically control the current or voltage of the welding circuit. These statements led to an investiga-

which was intended to determine the truth or falsity of such remarks. To completely test this point, five standard test pieces one-half inch in diameter were prepared and an arc struck on four of these pieces. In some cases the arc was merely struck and in other cases the arc was struck and carried along the test piece for a distance of an inch. During this operation no material was deposited from the electrode. The arc was merely struck and carried along the test piece. The piece on which the arc was not struck was tested along with others. The voltage of the arc welding circuit was approximately 60 volts, and the current approximately 150 Amps. The tests were carried out in the Westinghouse Works at East Pittsburgh.

The accompanying photographs show the specimens after they had been subjected to a pulling test. Photograph will show the test number, the ultimate tensile strength in pounds per square inch and the per cent elongation. The material was common hot roll steel with .1 to .2 carbon. Test pieces 5-1, 5-2, 6-1 and 6-2 were the ones on which the arc was struck and test piece No. 7 is the one which was not disturbed in any way.

The remarkable thing about the investigation was the ul-

timate tensile strength of all five pieces check closer than could be expected and that the piece which was not disturbed by the arc had a lower percentage elongation than any of the pieces on which the arc was struck.

This shows quite fully that the material on which the arc was struck underwent no structural change which would injure its original physical properties. Further, that there were no thermal disturbances set up in any way. Apparently the statements referred to above are in error, as the striking of the arc from the arc welding circuit where the potential is 60 to 75 volts does not in any way injure or depreciate the material directly under the arc. Therefore, the inverted cone of deformed material, as mentioned by many, is very probably without sufficient foundation to cause any concern to the users of arc welding.

Another interesting investigation which was made was one in which a solid plate was re-enforced throughout its entire length on one side with a deposit of metal from the electric arc. This solid plate which was re-enforced was cut from a sheet of steel which had an original tensile strength of approximately 56,000 lbs. After the deposit was made the entire added material was machined off, leaving the plate of the original thickness and the original material. The sheet prepared as described was subjected to a tension test and showed an ultimate tensile strength of 59,800 lbs. per sq. in. with 33 per cent reduction in area and 14 per cent elongation. The reduction in area in the original stock was 60 per cent and the percentage elongation was approximately 28 per cent.

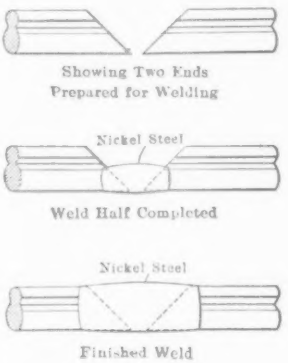
This test also tends to establish the fact that the tensile strength is not decreased either by the heat of welding or the striking of the arc.

OXY-ACETYLENE METHOD OF WELDING STEEL WIRE

As the correct welding of splices in steel trolley wire is so important, the method developed on this system is worth description in some detail. The successive steps in making a weld are shown in the drawing above.

The equipment consists of a Prest-O-Lite outfit of gauges, welding torch and tips. The torch is style H, and the size of the tip No. 5, this size being most satisfactory for our No. 0000 double-grooved wire. We first tried welding rods of Norway iron, but this led to crystallization. Our welding rods are now of ¼-inch or ⅜-inch diameter nickel steel, which is also furnished by the Prest-O-Lite Co.

The three-part sketch shows the different stages of a weld. First the opposing ends of the wires to be joined are cut at an angle of 45 degrees and a space of ⅛ inch is left between them to provide for expansion. The flame of the torch,



which is next applied, easily disposes of the galvanized scale which coats the wire.

As soon as both ends of the wire are at the melting point, the welding rod is introduced, great care being taken to keep both ends at about the same temperature. As the nickel steel is melted from the rod, it is fluxed with the steel trolley wire by means of the flame, starting at the bottom and building across and up. We found that we obtained a better application by running the welding steel around on the sides of the trolley wire; we also extended the natural top line of the wire for the sake of reinforcement, but we do not regard this as essential.

As soon as all necessary metal has been added, the weld while still red hot is filed down to a smooth under-run and shaped up as much as desired. Then cold water is poured on the wire, beginning about 1 foot on each side of the weld and running the heat toward the weld. Finally the weld is reached and wetted until perfectly cold. The average length of time to weld the wire in the air varies from ten to fifteen minutes, according to accessibility.—Extract from article in *Electric Railway Journal*.

WELDING *in* GAS MAIN CONSTRUCTION†

By M. S. Clark*

In this field the process of oxy-acetylene welding and cutting offers unique advantages to the gas distributor. With a small oxy-acetylene flame, which has a temperature of approximately 6,300 degrees, the metal on each side of the joint is heated to the fusion point, while a pure iron filling material in the form of wire is fused into the molten metal, forming a true fusion weld. By this simple method, pipe is joined together, and by the addition of filling wire the joint is given the required strength.

The extensive work in America, especially in the states of Pennsylvania, Ohio, Oklahoma and California, and the widespread practice abroad, have thoroughly demonstrated that welding is not only the most economical method of joining steel and wrought iron pipe, but that a welded main permanently eliminates joint leakage and subsequent maintenance cost. The oxy-acetylene process is not limited by the length or thickness of the pipe.

It is possible to use much lighter weight pipe in the case of a welded line, as no allowance need be made in the thickness of its wall to provide for threading, resulting in a large saving in pipe cost over a threaded connection line. In Europe, where the welded joint has been in use for a much longer time than in this country, pipe of 40 per cent less thickness than the sizes previously necessary for a threaded line are now used in their welded lines.

With a competent operator, the tensile strength of the weld ranges from 80 to 95 per cent of the tensile strength of the pipe itself. By building up the section of the weld, the strength of the joint is increased beyond that of the pipe. This strength in the joint and the fact that the welded main presents practically a continuous homogenous structure throughout its entire length permits of great flexibility in construction and is positive insurance against future leakage.

The apparatus generally used in field work consists of a four-wheel truck, on which is mounted a small acetylene generator, producing acetylene gas from calcium carbide and water, and also carrying a supply of oxygen cylinders. From the generator and from the oxygen cylinders are led hose to the welding blow pipe in which the two gases are mixed in proper proportion to produce the welding flame. You are all familiar with how readily calcium carbide is obtained all over the United States in hermetically sealed drums, containing 100 pounds each. Such a drum will produce sufficient acetylene to operate two welding torches for ten hours on ordinary pipe work. The use of the process has become so wide spread that oxygen is produced all over the United and furnished to consumers in different sized cylinders containing 200 feet each. The three cylinders carried on the truck contain sufficient oxygen to operate two blow pipes for about ten hours. Long lengths of hose, leading from the generator and from the oxygen cylinders, enable as many as six welders to work from a single unit. The cost of such a unit equipped to furnish the gas supply of two operators is approximately $650.

In cases where the extent of the welding is not such as to justify a company in making as large an investment in apparatus, a small two-wheeled truck designed to carry one oxygen tank and one acetylene tank, furnishing gas to one operator, is frequently used. In this case, the acetylene is supplied in tanks containing approximately 300 feet, sufficient to supply one operator acetylene for ten hours' work. The cost of such a unit is approximately $175. While the original investment is considerably smaller, the difference is soon absorbed by reason of the fact that the generator produces acetylene at a cost of approximately one per cent per cubic foot, and eliminates the transportation expenses incident to refill and exchange. Whereas, the cost of acetylene gas furnished in tanks costs from 2½ to 3 cents per cubic foot when handling charges are taken into consideration.

Facilities for the instruction of employes in the art of welding are offered by the larger manufacturers of apparatus. The employes may either go to the welding school conducted by such manufacturers, there to learn the art of welding, or the services of an expert may be secured at a nominal charge for the purpose of instructing the purchasers' employes on the ground. The welding of pipe is one of the simplest applications of our process. A man of ordinary intelligence can become proficient with a few hours' instruction and practice. Let me urge any of you who contemplate adopting the process to avail yourselves of the opportunities for instruction which are offered.

Pipe can be secured from the mills either in random lengths or in 40-foot lengths to reduce the number of joints to be welded, thereby affecting a corresponding reduction in welding costs. The mills will furnish all sizes of pipe in any lengths up to 40 feet with beveled ends without extra cost. By butting two lengths of pipe with beveled ends, a "V" groove is formed at the joints, enabling the operator to more easily penetrate the entire thickness of the wall, and at the same time facilitate a complete and proper fusion of both sections, with the filling wire which he adds. In cases where the ends of the pipe are square cut, the sections are butted up to within 1/16 to ¼ inch of each other, depending upon the size of the pipe and thickness of the wall. Sections up to 1,000 feet in length are welded together on the surface of the ground, and when completed dropped into the trench. It is obviously desirable to dig as long a ditch as consistent, in order that long sections of pipe may be dropped in and the number of joints to be welded in the ditch reduced to a minimum. At such joints a well is dug sufficiently large to enable the operator to make the weld in the trench by welding all the way around the pipe. The grading of the ditch must be observed as carefully as in the case of dresser couplings or thread connections to avoid low spots, but no particular care need be taken to have the pipe straight in the ditch; in fact, the more snake-like the pipe is laid, the better, for in this way expansion and contrac-

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*Oxweld Acetylene Co.

†Extracts from a paper recently read before a technical society.

on are taken care of. Experience has demonstrated that because of the great strength and flexibility of the oxy-acetylene weld, no other provisions to take care of expansion and contraction are necessary.

The best and most economical way of laying down the pipe preparatory to welding is on 2 by 4's or other timber at the side of the ditch. The pipe should be placed ends butting for the welder who is assisted by two helpers working at each end of the section, who turns the pipe with cham tongs, or other devices, so that the operator is always welding at the top of the pipe, a position in which the fastest work can be accomplished.

While many follow the method above described for all sizes of pipe, some engineers weld the larger sizes, 8, 10, 12, 16 and 20-inch pipe when supported from skids directly above the ditch. In this way, two operators can work on opposite sides of the pipe, which is turned by the helpers as rapidly as the work progresses. As fast as the welded section of pipe is finished, it is capped at both ends and tested for leaks at the desired pressure. After it has been tested, it is lowered into the ditch and welded to the main already laid. At such points in the ditch, a well hole is dug of sufficient size to allow the operator to weld entirely around the joint, as described above.

Aside from the enormous strength and efficiency of the welded joint compared with the mechanical forms of couplings, the new process is considerably more economical in installation and cost. It has been demonstrated that welded joints can be made at a cost of from 25 to 60 per cent less than the cost of purchasing connecting recessed screw couplings, while the economy is considerably greater in comparison with insulated couplings. On a line laid in a very rough and mountainous country, the following cost per joint based on labor at 35 cents per hour may be considered as a fair average for welded joints:

4 inch	$0.24
6 inch	.39
8 inch	.58
12 inch	1.57
16 inch	2.84

It has been found that an average welder can complete from ten to 13 joints per hour in 2-inch pipe, 3½ to 4½ joints in 4-inch pipe, 3 joints in 6-inch pipe. The welding of a joint on 8-inch pipe takes from 30 to 40 minutes, on 12-inch pipe one hour, and in the case of 16-inch pipe one hour and one-half. Where laterals are required, a hole of the proper size is cut in the main with a cutting blow pipe and the lateral is welded into place at any angle desired. In the manufacture and installation of special fittings, the welding process is in a class by itself.

The number of bends in a welded main is less than in the case of screw or dresser couplings, inasmuch as the pipe can be cut at any point and welded at any desired angle. Where a bend is necessary, the usual methods can be employed. A radius bend can be safely made in any section of pipe after it has been welded without any injury whatever to the welded joint. Laterals or service lines can be cut into the main by welding a short nipple thereto. The main can then be tapped through the valve installed on the end of the nipple, or a welded tee can be inserted in the main. The upright arm of the tee is threaded, and after tapping is closed with a cap. A bag hole may be welded up in the main by supporting a four-foot piece of six or eight-inch pipe a few inches over the hole, so that the flame is carried away from the operator. The welded line in the city is a preventive of damage, due to electrolysis. It has been found by test that the action is distributed over the entire length of the welded main rather than concentrated at any one point.

In the making of fittings, tees, crosses, drips, etc., the process is invaluable to the distribution engineer for, with the cutting and welding blow pipe, it is a simple matter, using odd lengths of pipe to cut and construct in the field fittings of any type desired, thereby doing away with the preliminary surveys and avoiding the delays incident to the securing of special fittings. Practically no pipe is lost, because all the odd lengths of the pipe which, under former construction methods would have been discarded, can be utilized for making various fittings at from 25 to 50 per cent of the cost of manufacture of special cast fittings.

I have called to your attention only a few applications of this new process, which is so rapidly becoming recognized by distribution engineers. When we stop to consider that the introduction of the process has come within the last decade, its practicability cannot be denied. With the increasing number of competent welders and the facilities which are now offered by the larger manufacturers for the acquisition of the art by its employes, the lack of competent operators which has done more to retard its development than anything else is being rapidly overcome. Few, if any, industries have seen as enormous developments as the oxy-acetylene process, not only in its application to the work in which you are especially interested, but in the manufacture and fabrication of practically all metal products in steel mills and foundries, in structural iron work, shipbuilding, in railroads and repair shops, in fact, there is scarcely anything used in this day in which oxy-acetylene has not played some part directly or indirectly.

HOW FAR SHOULD AN ACETYLENE CYLLINDER BE DRAINED OF GAS?

By C. J. Nyquist

This question is often asked by the users of dissolved acetylene. The question is one of safety, economy, efficiency and perhaps expediency. It is particularly important just at this time inasmuch as the government has use for all of the solvent which can be made or saved. And savings, as we know, represent values over and above costs.

Is it safe to draw acetylene from the cylinders when the pressure is lowered so far that the solvent is withdrawn? An acetylene cylinder represents not only a steel drum, a cylinder valve and a porous filling, but also a definite amount of solvent, usually acetone, required in order that a proportionate volume of acetylene may be safely charged into the cylinder. This amount of solvent is, of course, checked up and the deficiency made up when the cylinders are recharged but as the procedure is not automatic the human element has to be taken into consideration, regardless of the strictest control. Fortunately the large companies who market dissolved acetylene have left nothing undone for the safe use and handling of dissolved acetylent but that fact does not license the user to purposely and knowingly deplete the charge of solvent and thereby establish a condition which may result in danger.

The question of economy is, of course, of interest to the user. It is self-evident that every ounce of solvent lost from the cylinders must be added to the cost of production of dissolved acetylene.

It used to be a source of much annoyance when the gas manufacturers made it a practice to charge the acetone loss directly to the customers. While this practice was discontinued some years ago, it could not be expected that the manufacturers then would take the loss and, of course, the user pays for it now. At the present price for acetone extra cost is, no doubt, a very large cost item. Furthermore, acetylene is considerably cheaper than acetone and far more effective as a fuel gas for welding.

(Continued on page 30.)

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Rule of Thumb Methods.

WELDING is being done largely by rule of thumb methods. Thousands of successful welders are successful in spite of, and not because of proper training. When a job turns out properly, the welder "guesses" it's because of the flux, or because of the wire, or on account of a poor torch.

There is always a good, explainable reason for failures and the more scientific research we have the faster the trade will grow. That is why we are at present conducting a series of tests. We expect these tests to reveal a series of mistakes common to many welders.

A Letter From "Over There."

MEMBERS of the welding trade in this country will no doubt be interested in a letter received by *The Welding Engineer* from the French Welding Journal, which is situated in Paris. The letter follows:

Editors of *The Welding Engineer*. With our best wishes for 1918, we beg to inform you that we intend offering our services to all dear Americans, English, Canadians, Australians and Allies, who are required to serve in France in the Armies of our Allies.

Far from their families we think they will be happy to know they will find at the "Office Central De L'Acetylene, 104 Boulevard de Clinchy, the help and assistance they may desire.

We shall not only be happy to welcome them when they are staying in or passing through Paris, but we shall be proud to help them with correspondence, with parcels, or with such other difficulties as they may find themselves in.

We propose, through your interference to be their friends and devoted correspondents here, and to smoothe, by all means, the rigors of their present exile. They can, therefore, apply to us in all circumstances. We shall put ourselves entirely at their disposition.

We beg to give the greatest possible publicity to our desire to serve.

We remain, dear sirs, yours truly,

Pierre Rosemberg.

We would remind readers of *The Welding Engineer* that Messrs. R. Granjon and Pierre Rosemberg, under whose direction Francis Welding Journal is published, are the joint authors of what is probably the most complete and best work on welding written up to this time. If for no other purpose than to meet two such distinguished members of the craft we would recommend that our friends who are going to France call at 104 Boulevard De Clichy.

In behalf of American and Canadian welders, we thank our French friends for their kind offer and in return we only hope that the work to be accomplished "over there" by welders will be up to a quite proper standard of efficiency.

Test Department.

CONGESTION in the mails is responsible for our not being able to publish in this issue the second installment of the series now running. The second report will be published in the March issue and the third in April.

Two distinguished members of the trade have been honored by the War Department. J. M. Morehead and R. A. Shaw, Union Carbide Co., have been commissioned majors in the Ordnance Department.

HOW FAR SHOULD CYLINDER BE DRAINED?

(Continued from page 29)

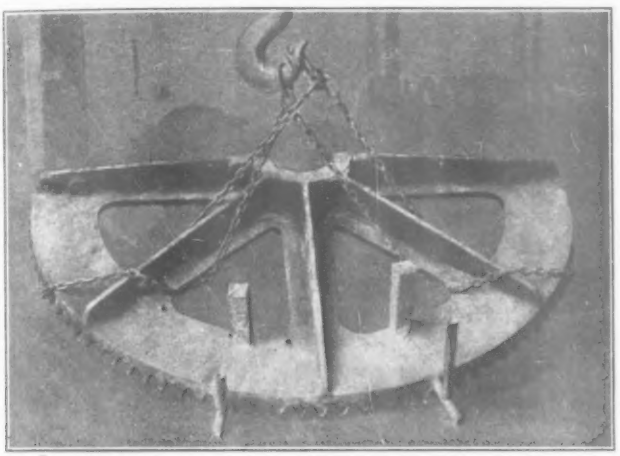
The oxy-acetylene-acetone flame, which is the result when using the gas from a nearly-empty, acetylene cylinder, has practically the same appearance as the proper oxy-acetylene flame, the white flame cone is in fact longer but the heat value of the flame is much lower. This means, of course, that the time loss and the consequent proportionate loss of oxygen more than outweighs any saving of fuel gas which could be accomplished by the improper use of the solvent. Not only does it take a much longer time to weld with oxy-acetylene-acetone flame, but the flame is positively injurious, at least, to molten steel, a fact easily proven by comparison.

Loss of acetone occurs when the flow of acetylene from a cylinder is too rapid. The manufacturers of the gas recommend that only one-seventh the capacity be drawn per hour or in other words that not more than 14 cu. ft. per hour be used from a 100-cu.-ft. cylinder and not more than 43 cu. ft. per hour from a 300-cu.-ft. cylinder. If more than the above stated volumes are required, two or more cylinders should be connected up by special connections. This does not, however, mean that large manifolds and pipe lines are permitted, as that would lead to the storing of considerable quantities of free acetylene under high pressure which is a very hazardous experiment and may prove disastrous. Acetone is also withdrawn rapidly from the cylinders if gas is used when the cylinder pressure is low. One manufacturer states that excessive acetone loss takes place when the pressure is about or below ten lbs. and advises that no gas should be withdrawn when the pressure has reached that low level. He also states that the volume of gas the customer pays for is over and above the amount held in the cylinder at that pressure.

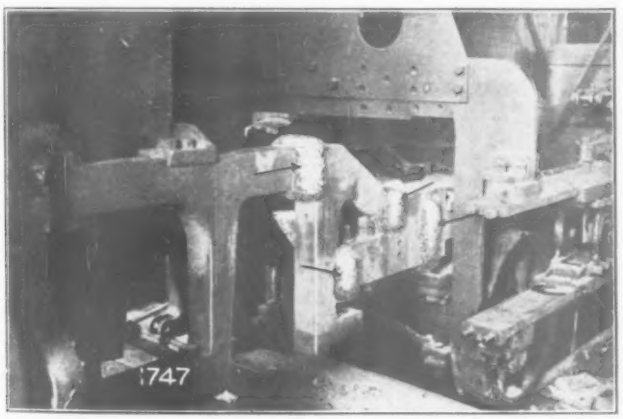
At present the demand for dissolved acetylene exceeds the supply. Owing to the shortage of acetone, it may become necessary to penalize the waste of this valuable material.

If wasting of the solvent is neither safe, economical, nor efficient, why waste it?

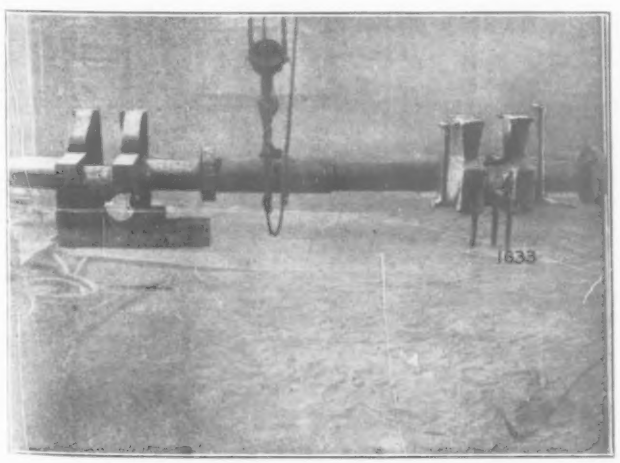
New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.



Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.

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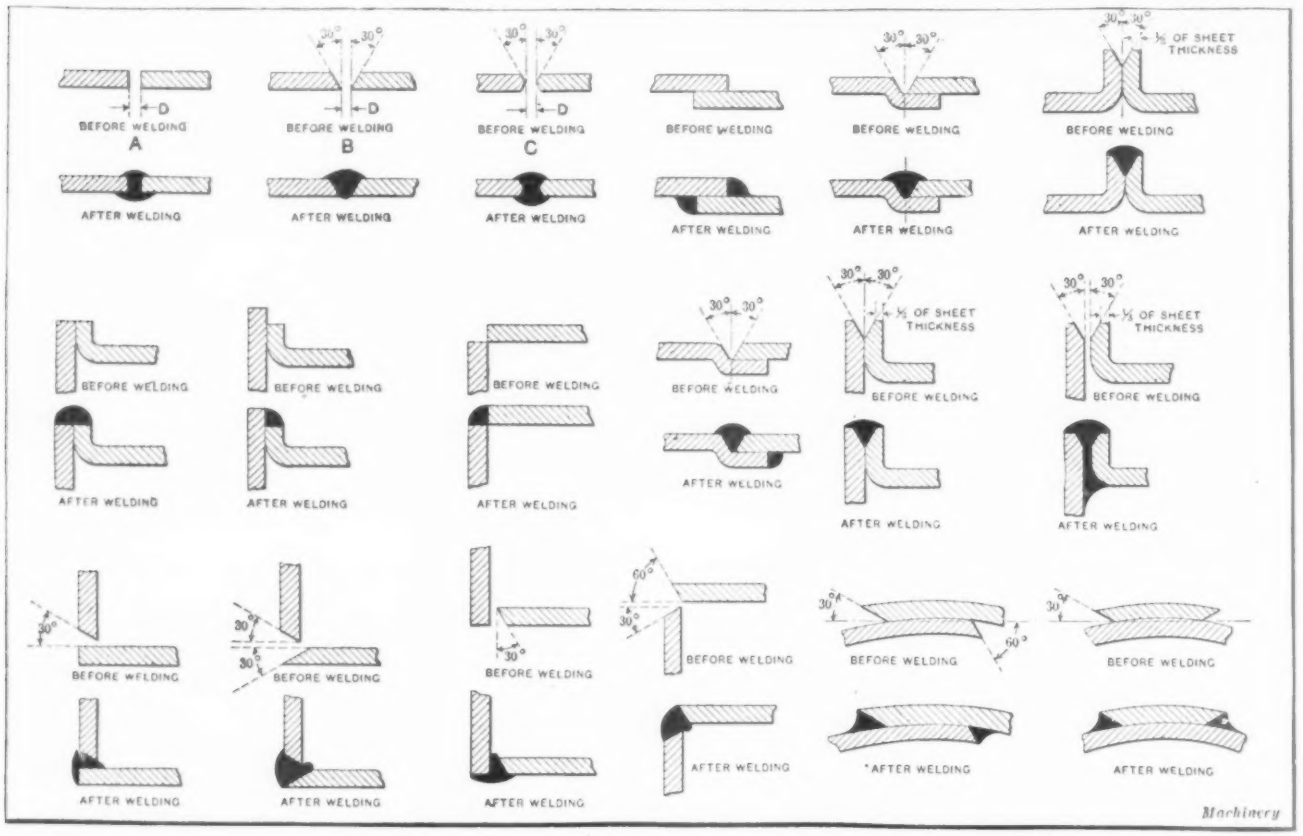
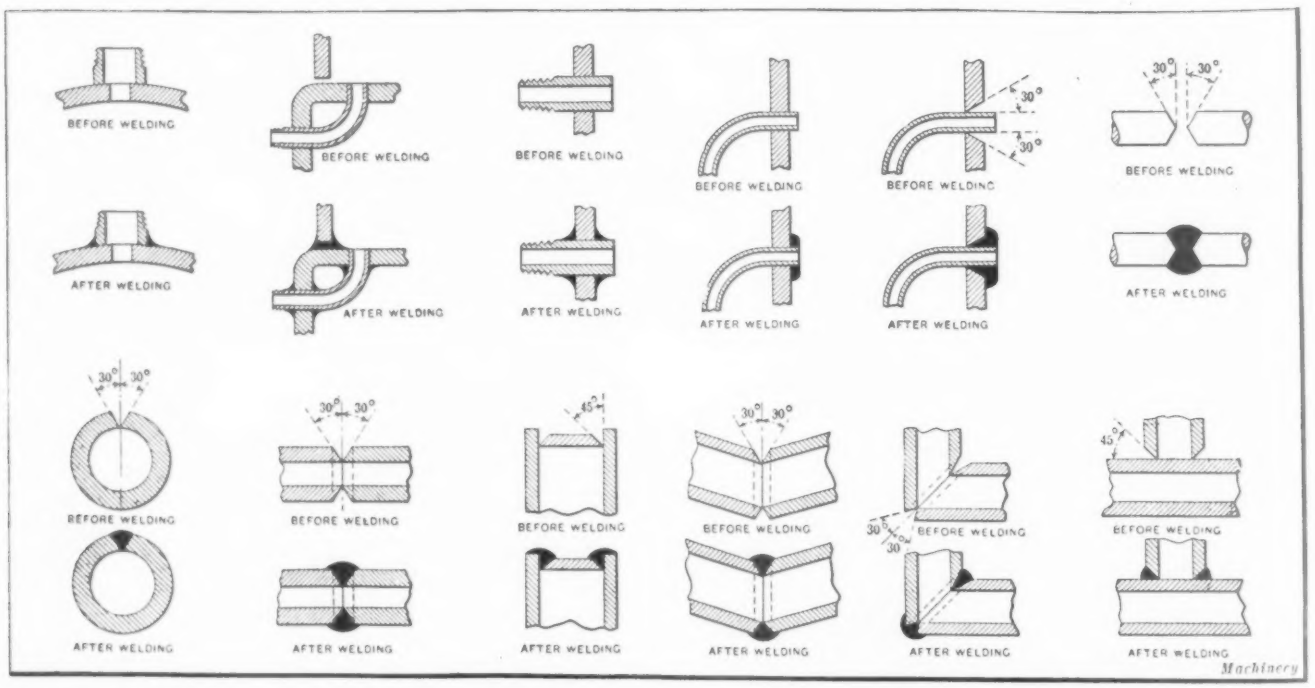
APPLICATIONS OF ELECTRIC WELDING TO RAILROAD SHOPS*

There are a great number of instances where electric arc welding may be used to advantage in railroad shops. In fact, the railroad shop offers one of the greatest opportunities for the application of the process. It is used to a large extent in many shops in building-up operations. Practically every steel casting on a locomotive is subject to wear at several points. Where worn, the metal may be built up again, by means of the metal electrode process, both cheaply and rapidly. Most of these building-up operations are done with a 5/32 or 3/16-inch electrode. The use of smaller electrodes is not economical, owing to the slow progress of the operation. The use of larger electrodes is inadvisable on account of the difficulty in controlling the metal. Metallic electrodes should be used in preference to carbon electrodes for welding of this kind, for the following reasons: (1) Steel castings welded with a carbon arc would have to be annealed, which entails additional cost and delay. (2) The metal can be deposited at the exact place where it is required more accurately by the metal electrode





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process than by the carbon electrode method; and, therefore, while the carbon arc process is somewhat more rapid than the metallic arc method, the time saved in the welding operation by the carbon arc would be lost in the machining operation on account of the inaccuracy of the location of the deposited metal. (3) The operator requires less skill in the use of the metallic arc than in the use of the carbon arc when the process is used for building-up operations; when applying metal with a metallic electrode, the operator is forced to move along as fast as the metal is deposited; with the carbon electrode, he may dwell longer, but is, however, likely thereby to produce a burned spot. (4) Hard spots are not produced when the metal electrode process is used for building up.

Flue Welding

Electric arc welding is also frequently used for welding in the firebox and for flue welding. The process recommended by a sub-committee of the Association of Railway Electrical Engineers is as follows: Welding in the firebox should be done with a 1/8 or 5/32-inch electrode. The best metal is obtained in the weld with these sizes. The amount of heat is as small as can be economically used. It is evident that, owing to trouble from expansion and contraction, the quantity of heat it is possible to use in welding flues or firebox sheets is limited. The ideal preparation of a set of flues for welding is as follows: (1) Put flues in exactly as if they were not to be welded. (2) Fire the boiler, or, better still, send the engine out for a run. The object is to burn the oil out from under the beads of the flues. (3) The flue sheet should then be brushed with a stiff wire brush or sand-blasted. The object is to eliminate, as far as possible, the scale of oxide on the flue sheet and flues. Iron oxide is not a good conductor of electricity and causes difficulties with the arc, which, in turn, may produce a poor weld.

The welding of 2-inch flues is best done with a 1/8-inch electrode. On sand-blasted flue sheets, from 90 to 100 amperes is enough current. Flue sheets that have a thick coat of oxide require from 120 to 130 amperes with this size of wire, and the weld will not be satisfactory. Five-inch flues should be welded with a 5/32-inch electrode and with from 120 to 140 amperes, depending upon the condition of the flue sheet.

Cracks or Seams

Cracks and patch seams offer the most difficult problems to the operator. A crack should be located and a ½-inch hole drilled at least two inches beyond each end. The edges of the crack should then be beveled so that the operator can reach them to make the weld. On horizontal cracks, the lower edge does not need to be beveled, but should be chipped to produce a square edge. The upper edge should be beveled at last 45 degrees. Vertical cracks should be beveled from 30 to 45 degrees on each side. The less material removed from the crack the better. All welds should be made with the least possible amount of metal between the edges of the original material.

If the crack or seam is a long one, the metal should be put in alternate sections of from four to six inches long. The operator should put one layer of metal in each of these alternate sections, starting near the center of the seam or crack. The open sections can then be filled, starting at the coolest point. Successive layers of metal can then be applied until the seam is completed.

Wherever possible, at least 30 per cent of reinforcing should be applied so that the cross-section through the weld is 30 per cent greater than the section of the original plate. After each layer of metal is welded into the seam, it should be thoroughly brushed with a stiff wire brush to remove as much of the oxide as possible.

*Extracts from "Electric Arc Welding," in *Machinery* for December, 1917.

INSTRUCTING WELDERS

In Order to Instruct Welders in an Art That is Finding World-Wide Application, an Institution Has Been Established.

By Henry Cave.

The welding of metals requires more than "horse sense." It is something that one must prepare for, if he is to be proficient, or is to be looked upon as an expert, and surely no man should fail to aspire to utmost efficiency.

In the welding of metals many conditions are met with, and many types of metals are placed in the hands of welders, metals of different composition and requiring correspondingly different handling.

In order to meet the need and demand for experts in the art of welding, a welding institute has been established at Jersey City, N. J., where the human element may be handled in a way to make it of greatest avail in this field where the human element cannot be overlooked.

In the past the industry, so far as welding is concerned, has been confined very largely to salvage work. The greater part of this work is of such a nature that the strength per square inch of weld is not a factor of extreme importance, as most parts of machinery have a very large factor of safety and their breakage usually occurs due to an accident, and not due to the part being strained in ordinary use beyond its ultimate strength.

This being so, a weld having an efficiency of only 50 per cent is ordinarily amply strong, and the metal that can be added as a reinforcement will generally insure satisfaction. The work turned out by the general welders, to date, is not really indicative of the possibilities of the process. There is a big field for the process, outside of salvage work under conditions where strength is of extreme importance. This includes the large variety of articles such as pressure containers, some of which have been welded in the past unsatisfactorily, and caused considerable criticism of the process.

Instructions to the student welder have been very meagre, usually being given by some practical welder. The welder, though he may be extremely proficient in his art, might not have the ability nor the desire to impart the knowledge to others so that the student acquired little valuable information. This makes it necessary for him to experiment on production work, resulting in poor work and criticism of the process.

The ability required to instruct appears to have been overlooked. The skilled welder, not having any special knowledge of this science, does not know how best to impart the information which he may possess to the student. He may not even know the particular factors that have been responsible for his success and therefore may overlook the most important features of instruction.

The gradual development from helpers is another way in which welders have been obtained. Such men frequently serve years as helpers before they get an opportunity to handle the torch sufficiently to be of use in actual production.

These slow methods of producing skilled welders have been very largely responsible for the selection of men of comparatively low mentality at small wages, owing to the protracted period necessary for this kind of instruction.

Ninety-five per cent of the welders have never had an opportunity of learning the real strength of the welds which they produce. By extensive practice they have become sufficiently skilled so that their work has proved fairly satisfactory. Therefore, they and those in touch with them assumed that their welds were strong.

Tests of the work of such welders has shown that very few of them can make a really strong weld in steel, which is more

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difficult than cast iron, largely owing to the fact that the oxide melts at a lower temperature than the metal itself. Steel is an imporant factor, as it is always used where strength is required, cast-iron and non-ferrous metals only being used where tensile strength per square inch is of little importance.

The use of such welds on pressure containers and other articles where strength is of vital importance is attended with considerable risk.

The Institute is overcoming these difficulties by using teachers experienced in instruction and the uses of metals. Students who have been trained in the fundamental principles of the art of welding, have proved to be best. These teachers impart their knowledge to the students by carefully-thought-out methods and under conditions which will eliminate loss of time to the learner.

The student is given sufficient practice in each operation whether it be setting up and adjusting the apparatus or arrying out the various phases of welding, as will insure his skill in that particular direction. His time will then be devoted to other things and the preparatory work which will not help him in the development of the art will be carried on by others. In this way the time spent in the actual use of the torch will bear as great a percentage as possible to the time allowed for his instruction. The remainder of his time will be taken up with tests and lectures. Each step he takes will be carefully analyzed for him and the results demonstrated by suitable tests, including the pulling of samples of his own work in a 100,000-pound Riehe testing machine.

In this way he will not only have a thorough knowledge of how to carry out the work, but will have his muscles under control so that he can operate in the best possible manner. He will also have a thorough understanding of the reliance that can be placed in his work, which is a factor of ext eme importance.

To give the most efficient instruction there must not only be ample room and full equipment, but the highest class of instructors must be employed. Large quantities of metals, and liberal supplies of gases must be provided, all of which must be taken into consideration in estimating the cost of giving such instruction.

It is far more economical to employ this method of teaching than to put a cheap man into the shop where he will consume much of the time of a high-priced employe in learning, and spoil much of his work over a long period, resulting, after all, in producing a very ordinary operator, with little basic knowledge of the art. While men who are already considered expert welders, foremen, superintendents or exceptionally fine mechanics, can learn much that will benefit them in a week, it is necessary for a beginner to take a course of two weeks or a month.

To conduct an institute for the instructing of welders and the informing of foremen of how welding should be done, means the employing as instructors of those who have had practical as well as technical experience. Since the practical man is the man connected with the every-day use of welding equipment for all sorts of purposes, an institute, such as indicated, could not be better located than where thoroughly practical men are found, namely, under the same roof as houses an institution that has grown up in the industry from its very inception, and is under the management of thoroughly experienced and practical men. Such an institute is that known as the Davis-Bournonville welding institution of Jersey City, N. J. —*Natural Gas and Gasoline.*

ARMY SCHOOL AT PEORIA

The School for Welders, being operated by the Ordnance department at Peoria, Ill., is said to be a success. The interest shown by student soldiers has surprised and pleased officers in charge. This school is turning out men for the Motor repair section.

WELDING TRACK BOLTS IN RECONSTRUCTION OF TRACKS IN PAVED STREETS

By Clifford A. Elliott, Cost Engineer, Maintenance of Way Department, Pacific Electric Railway Company, Los Angeles, Cal.

During the past few years it has been the practice of the Pacific Electric Railway Company, when renewing railroad crossings and other special work layouts in the paved streets of the municipalities of Southern California, where its lines are operated, to weld the nut of the machine bolts used in the joints, to the toe of the bolt. It has been found that this practice is advantageous in securing a more rigid joint, which is always most desirous in and about the various types of special work—with view of prolonging its life; especially the layouts that are subject to exceedingly heavy wear and tear from frequent traffic in the larger cities. The welding of the machine bolts in this manner is to provide absolute security in the joints, as this type of bolt, being round in its construction between the head and toe and absence of a shoulder on same, permits the bolt to turn when tightened up, thus working itself loose or backing out of its original position, which soon causes loose joints contiguous to the special work, thereby forcing the layout to become out of surface and line, requiring early excavation of pavement for repairs to both joints and special work.

Since this practice has been in vogue it has, also, been made a standard one for all tracks when reconstructed in paved streets with 6-in. 72-lb. T-rail, 7-in. 91-lb. T-rail and 7-in. 127-lb. grooved girder rail, these being the standard sections of steel used by the company within pavement.

The apparatus used for this welding work is a portable ventilated electric arc welding machine constructed in the company's shops, with permission of patentee upon payment of certain fixed royalty; the principal purpose of the machine being in service is for reclaiming all classes of built-up and manganese special work. The company now has four such machines in service for this purpose. By this method the life of the layouts is extended from three to eighteen months, which allows ample time to prepare plans and have new layouts fabricated for renewal.

This machine is 2 ft. x 4 ft. x 6 ft. in size, well made and mounted on a wheel base, total weight 1,250 lb. It can be handled by two or three men. Power, taken from the overhead trolley wire at 550 to 600 volts, is brought down through the resistance coils and comes out of a plug, into a tube through the end of which is placed a piece of round tool steel. This tube is constructed so three different sizes of round tool steel can be inserted, according to the size in stock. However, $\frac{3}{4}$-in. in diameter Acme special tool steel in a majority of cases has been adopted as the standard for the welding of the bolts and reclaiming built-up special work, while a different type of steel, especially adopted, is used for adhering to or in repairing the manganese layouts. The special type of tool steel selected for this latter work is 7-32 in. in diameter, and for this purpose is supplied by the Indianapolis Switch & Frog Company.

The method of welding is as follows: After the tool steel is placed in tube all that is then necessary to do for the welding operation is to make a contact with the point at which welding is desired, which is grounded to the main return, then resulting arc melts from this rod, thus forming the desired weld on the bolt or special work. Although it is to be borne in mind that the presence of low voltage is discouraging, as it will only melt the tool steel, with results of a very poor weld. Usually a piece of tool steel 18 in. in length is practical for the work, and men of experience operating the machine will not permit any waste, as when steel becomes melted away as to be barely of any further service, a new piece can be immediately welded to the stub piece with very little delay to the original operation.

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Eliminates pin holes and blow holes, leaving the metal soft.
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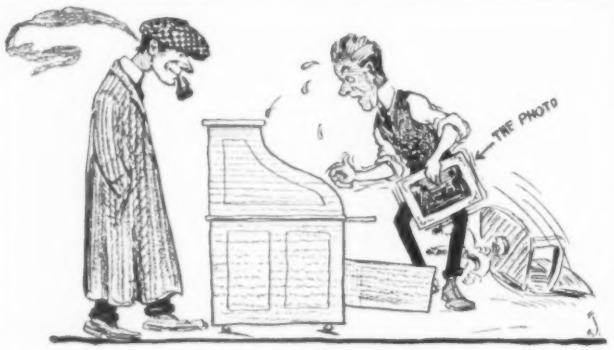

Hold on! What were you doing just then? Storing away that interesting bit of welding experience, or a photograph, perhaps? Don't do it? Give it to us. We want to show it to 4,099 other readers of The Welding Engineer (you're the forty-one hundredth). If there are objectionable features to it, just leave it to the Editor (he studied surgery), cutting off and adding to is his hobby.

Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

If the welding industry is to grow, you welders must pass along your experiences. We pay for them.

THE WELDING ENGINEER
608 S. DEARBORN ST., CHICAGO

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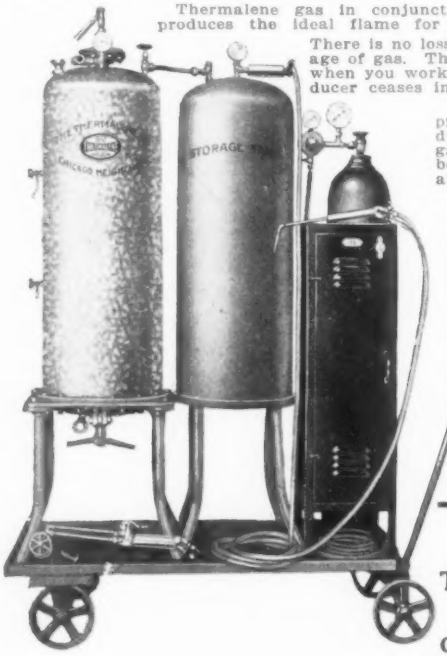

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A New Book on **AUTOMOBILE WELDING**
With the OXY-ACETYLENE FLAME By M. Keith Dunham
167 Pages **Price $1.00** *Fully Illustrated*
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Explains in a simple manner apparatus to be used, its care, and how to construct necessary shop equipment. Proceeds then to the actual welding of all automobile parts, in a manner understandable by everyone.

Gives principles never to be forgotten. Aluminum, cast iron, steel, copper, brass, bronze and malleable iron are fully treated, as well as a clear explanation of the proper manner to burn the carbon out of the combustion head.

Automobile Owners, Garage and Service Stations, Blacksmiths and Machine Shops, as well as industries using the oxy-acetylene flame, will find this book of the utmost value, since the perplexing problems arising when metal is heated to a melting point are fully explained and the proper methods to overcome them shown.

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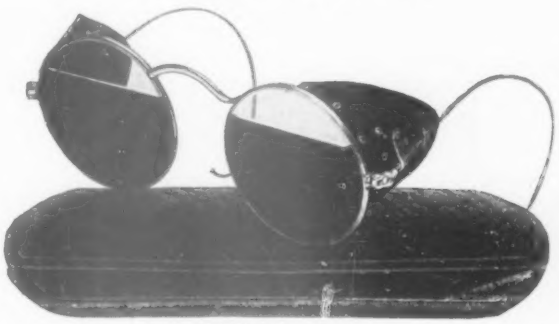

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Solid white metal frames, easy cable temples, leather sides and adjustable bridges.

Upper part, clear glass; lower part, gray green Hallauer glass for welding.

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Before the welding operation on the track bolts is undertaken, according to standard practice, the ends of rail are brought up to full surface and gage line; standard concealed bonds for continuous joints in paved streets are applied; then continuous joints correctly applied and all track bolts securely drawn.

Some of the lines are operated where 1,200-volt trolley exists; consequently, the welding machine as mentioned is not equipped for this high voltage; therefore a No. 3 Oxweld acetylene welding torch is maintained in service for use in welding bolts and special work in paved streets in this particular territory.

Conclusive that maintenance of tracks in paved streets is a tedious problem, and one of excessive expense; therefore, at time of reconstruction, where a good standard of construction is observed, it would be expected of such construction that the track in pavement would have a life of at least 10 or 12 years. However, unless the track bolts are made absolutely secure by some special method, it is soon evident that excavation of the track within the pavement is necessary to tighten the bolts and again restore the joints to proper surface and line, which constant requirement, conclusively shortens the contemplated life of the track as a whole. Frequent excavation of the joints for retightening the bolts is unwelcome, expensive maintenance and uneconomical policy, whereas, unless the bolts are made rigid by some method at time of original placement, it is not long before this item becomes one of the greatest importance in the general program of maintenance work on tracks in paved streets. Also, the life of the bolt under these conditions will terminate within approximately three years—after which period its renewal is required. By welding the bolt under the process outlined, it does not require its disturbance until absolute renewal of the bolt is required, which is several years beyond that of the unwelded bolt.

Therefore, a more rigid joint is obtained, avoiding early renewal of the joints due to their damage from loose motion of insecure track bolts; also reducing frequent resurfacing, relining and repaving maintenance expenses to the minimum. In addition, it is evident when a rigid joint is always maintained in pavement that there is a minimum disturbance to same for excavating to remove the joint to renew or repair the bonds, which are always vitally affected and have a tendency to work loose from the action of a playful joint. This preventive is one that reduces bonding maintenance in pavement to a minimum.

Further, there is much public favor gained from municipality authorities by not having the tracks almost constantly excavated for correcting such frequent defects at the joints.—*Electric Traction.*

ADVERRTISNG THE JOB SHOP.

Mr. H. T. Millard, an Ontario, Canada, welder is one who believes in publicity. He overlooks no opportunity to advertise his job welding shop. In a recent issue of *The Welding Engineer* an article was published on "Welding Helps The Navy," which was an interesting account of the emergency repairs made to interned German liners. Mr. Millard furnished this article to his local newspaper, with appropriate mention of his establishment.

Classified Ads

Help Wanted—25c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—50c per line, minimum 4 lines.
Count 8 words to line. Add 6 words for keyed address.

SALES CORRESPONDENT—now with Prest-O-Lite Co.—desires position. College graduate, 28, married, draft exempt. He is an energetic sales promoter, possessing vigorous initiative. Knowledge of foreign languages and export work. Unquestionable references. Marcuse, [illegible] Hendrix St., Brooklyn. Feb.

Wanted—Expert welder with knowledge of manufacturing oxy-acetylene equipment can learn of good opportunity by addressing Box 6301.

Wanted—Second hand acetylene generator. James Austin, 32 O'Neil St., Kingston, N. Y.

For Sale—One acetylene generator, 200-pound carbide capacity, Oxweld duplex type, low pressure. Little used and guaranteed to be in excellent working condition. Hugh W. Dyar, 140 South Dearborn Street, Chicago. 1t

Wanted—Salesman to solicit subscriptions to *The Welding Engineer*, or furnish names of possible readers. Compensation good. Correspondence confidential. Write Mackenzie.

Wanted—Experienced welder, to take half interest in an established commercial shop doing a good business and growing fast in California. Must be adaptable to all class of work. Trifflers and hit or miss welders not wanted. Box 9, care *The Welding Engineer.*

Wanted:—Two large Prest-O-Lite, Commercial or Searchlight welding cylinders. State style and lowest cash price. Wilkes Barre Welding Co., Wilkes Barre, Pa. 1—2

Wanted:—One cast iron face plate for use in oxy-acetylene welding work, approximately 3 ft. by 6 ft. Address Face plate, care *The Welding Engineer.* Jan.

WANTED:—Two No. 1 welders. Steady work (9 hrs.) No labor trouble. Men must thoroughly understand their business. Superintendent in charge, oldest welder in country; hit or miss operators won't do. Rapid advancement. Address Box 27, care *The Welding Engineer.* Jan.

Wanted—Foreman for welding department. Both oxy-acetylene and electric. Write stating experience, age and salary expected. Struthers-Wells Co., Warren, Pa. 1t—Jan.

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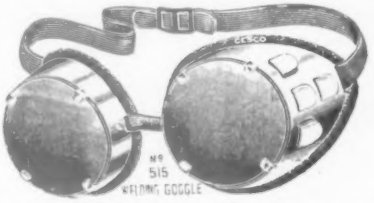

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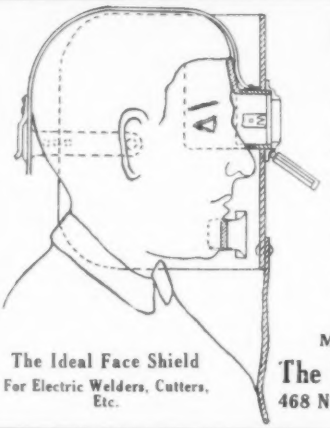

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The rail transportation system of this country is so vast in its proportions, that in normal times there are from four to five thousand locomotives—or practically 15% in the repair shops. It is estimated that if this percentage could be reduced to 10, over three thousand locomotives would be made available. How **vastly important** then is **the repair problem.** Today every industry is taxed to its capacity, and repair parts cannot always be obtained promptly. The importance of The Westinghouse Arc Welding Outfit as a means of making lasting repairs quickly and economically, cannot be overestimated. It is a simple and reliable way of making hundreds of miscellaneous repairs. The Westinghouse Arc Welding Set is a conserver of both time and material.

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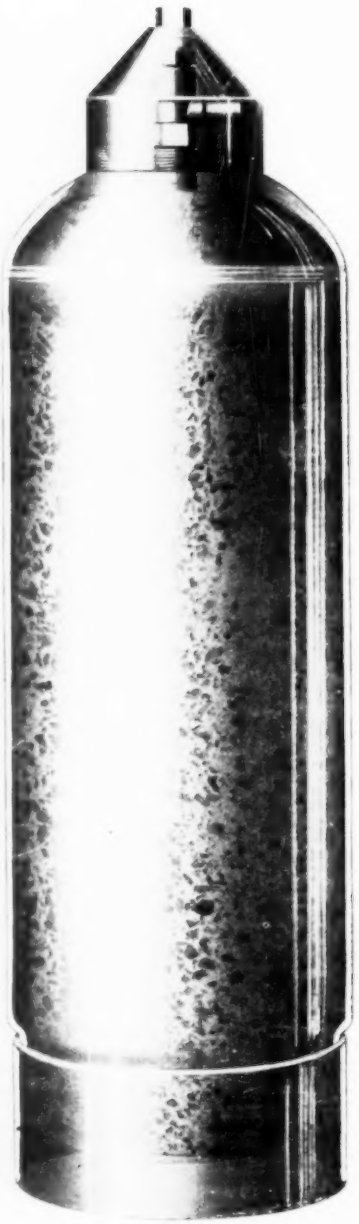
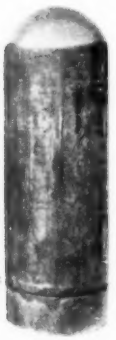


Forming the Shell



After the various drawings the Shell is now ready to be closed in on the top or head end. This open end is heated to the proper temperature and pressed over until the end is completely closed, the heat being such that the metal is welded during the pressing operation.

This method required several years' experimenting before success was finally attained, and it is due to this operation that we are able to give to the welding industry the only Seamless, One-Piece, Acetylene Cylinder made. The foot ring and ring for protecting cap are then welded in place by the oxy-acetylene process.

Commercial Acetylene is the PUREST that can be manufactured, and is furnished in portable cylinders of 125, 225 and 275 cu. ft. capacities for welding and cutting under our free loan plan—NO DEPOSIT REQUIRED.

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